THE STORY OF THE SEAMAN

JOHN FORSYTH MEIGS

American clipper-ship Flying Cloud built in Boston 1851: she measured 1783 tons; twice made the run New York to San Francisco in 89 days; the only other ship that made the passage so quickly was the Andrew Jackson. Her model 1/96 size in Peabody Museum in Salem, Massachusetts.

See below as to this ship.

THE STORY OF THE SEAMAN

BEING AN ACCOUNT OF THE WAYS AND APPLIANCES OF SEAFARERS AND OF SHIPS FROM THE EARLIEST TIME UNTIL NOW

BY

JOHN FORSYTH MEIGS

LATE UNITED STATES NAVY

IN TWO VOLUMES

VOL. I.

ILLUSTRATED

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INTRODUCTORY

Unfortunately for this book the author did not live to write its preface; explaining its application to present day conditions.

The subject, dealing as it does with growth of commerce, is a timely one and the varied professional experience of the author eminently fitted him to treat of it after his retirement from business.

The commercial exchange of the products of specialized industries is the basis of civilization. Early in human development, the exchange of industrial products took place within the smallest of closed circles, scarcely larger than the family. As specialization developed, not only did production increase, but the rôle of the merchant extended and he assumed an ever growing share in the advance of civilization. Water transportation was the cheapest, and in spite of the dangers of the sea and of human violence, it was for long ages the safest means for exchange of goods and of ideas. Throughout all the centuries of history, it is the merchant-adventurer traveling across the seas for gain who has stood for the progress of the world, no less than the thinkers, the rulers, and the soldiers who fill the records.

This Story of the Seaman, tracing the development of water-borne commerce, has two sides;—the traffic itself and its protection in transit. The two are inseparable. As a result of weariness of the recent great war, the world is now passing through the ever recurrent mood of pacifist tendency. This is not the moment to forget the saying of the gospel, "When a strong man armed keepeth his palace, his goods are in peace." The Story of the Seaman is really the story of the merchant armed, spreading civilization and well-being.

When this country parted from Great Britain and set up for itself, its prosperity was based in great part upon its sea-borne commerce and its bold New England merchants. But early in the nineteenth century the internal growth of the nation and then the Civil War together checked the development of our foreign commerce for two generations. Now, with the entire country settled and prosperous we are turning once more to establish our foreign commerce in American ships as a necessity to maintain our world position in business.

In this book we may follow the development of shipbuilding and the other maritime arts and see how the art of naval warfare developed simultaneously step by step for the protection of trade.

With the great advances made in transportation during the past century, the specialization of industries is growing ever greater and greater. The two are bound together like the Siamese twins and transportation is becoming more and more important to the life of the world. The nearer any nation comes to controlling international transportation, the nearer she will come to ruling the world; for production is more and more controlled by the means available for placing goods before the consumer.

Study of the history of commerce and its wars teaches us to expect and believe that the continuation of our national welfare and the maintenance of our position among the great powers of the world; our ability to make our voice heeded among nations, depends largely upon our cultivating a class of merchant-adventurers such as the country was fortunate enough to possess a century ago. Our new merchant shipping must be American-owned and supported abroad by American banking systems and distributing agencies, all upheld by the strong will of the people and protected by a navy second to none. Such is the lesson which this book helps to convey: let us not fail to apply it to the present situation.

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John Forsyth Meigs was born in Philadelphia in 1848 and was named for his father, a distinguished physician of the city. He was brought up in Philadelphia, and on his fourteenth birthday he entered the United States Naval Academy. The country was in the middle of the Civil War and for safety the Academy had been moved temporarily from its site at Annapolis to Newport, R. I. In the summer of 1864 several of the practice ships of the midshipmen were diverted by the Navy Department from their annual summer cruise to engage in the pursuit of the rebel cruiser *Tacony* which maintained herself for three weeks off the Atlantic coast to the terror of shipping and in despite of all the efforts of the Federal Navy to seize her. Thus early was the writer brought to reflect upon the welfare of commerce as a national asset and its dependence upon armed fleets.

When Meigs graduated the Civil War had ended. It had completed the destruction of our foreign going shipping; the people were absorbed in the internal expansion of the country and the reaction from the emotions of war entailed the neglect of the navy, the handmaid of trade.

This period of neglect of the navy lasted fifteen years; during these years Meigs served at sea, visiting Asiatic, European and South American waters; he also served at the Naval Academy as instructor in the department of gunnery where he laid the foundation for his future work in civil life as ordnance engineer. In conjunction with others he wrote a text-book on ordnance and gunnery which was long an authority.

In 1878 he went on the staff of the Commander-in-chief of the Pacific Fleet and thus had an opportunity of observing the war between Chile and Peru which broke out in 1879 and of noting the advantages in ship construction and battle training which brought success to Chile.

In 1886–87–88 Meigs was on the staff of Admiral S. B. Luce, Commander-in-chief of the North Atlantic Fleet. Admiral Luce was one of the leading men of the navy, whose energy and vision had much to do with the uplift of the navy from the slough of despond into which it had fallen after the Civil War.

In this revival, Meigs lent his strong arm to the Commander-in-chief by taking charge of gunnery training and organizing the methods and records of the fleet so as to make the improvements of individuals both permanent and promotive of general naval efficiency.

In 1891, to his great regret, Meigs was placed on the retired list of the navy for color-blindness and soon afterward found employment with the Bethlehem Steel Works, becoming its Engineer of Ordnance in 1895. He reorganized the company's ordnance department in 1898 and was able to convince foreign military and naval attachés of the Company's competence to furnish armor, armament, and ammunition for men-of-war and coast defences. He made several trips abroad to represent the Company at the seats of foreign powers and was constantly in communication with the ordnance departments of our own army and navy. His interests and duties with the Bethlehem Company were thus not only those of ordnance engineer, but also those of a merchant and commercial man, selling the products of the United States in foreign lands.

In 1910 Meigs resigned from the service of Bethlehem and, as an avocation, took up the studies of the art of maritime transport and the protection of traffic which have resulted in this book. The outbreak of the great war in 1914 which caused so many men to return to work which they thought they had laid aside forever brought Meigs again into harness as ordnance engineer. It was not until after the armistice that he was able to resume his well earned leisure and employ it in tracing out the ways of

his predecessors on the seas. He followed his task with the utmost diligence until his death in the spring of 1924, while he was revising the final proof-sheets of this book.

As we have seen, in his life's work, Meigs followed in his own person both sides of the business of the sea, as did his predecessors in centuries past. His calling was that of arms and he was also a manufacturer and a merchant. The great specialization of industries, which is one of the distinguishing attributes of present business economics, has separated the pursuit of arms from that of trade. In municipal and in national life we do not forget that security for business is only to be reached by the protection of armed strength and such is duly provided in every peaceful and prosperous country by the police. But, unfortunately, as to international relations, there are too many people who assert that permanent security for international business may be maintained by international agreement. The complete severance of international commerce from national protection therefor is now tending to make this country in particular lose sight of the necessity for protection.

The perusal of this book will answer its author's hope if it helps its reader to perceive that the complete mariner is both seaman and warrior, and our country, to be truly prosperous and safe must create an adequate merchant fleet and preserve its strong navy.

William Ledyard Rodgers,
Rear Admiral, U. S. N.

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CHAPTER I.

Introductory: The Phenicians; Position-Finding at Sea; Marinus of Tyre, Maker of Maps and Seamen's Charts; Codes of Maritime Laws.

"Of all the inventions and improvements the wit and industry of man have discovered and brought to perfection none seems so universally useful profitable and necessary as the art of navigation." Such are the words John Locke English philosopher and man of letters writes at the beginning of his Whole History of Navigation. He wrote in 1700 and means by navigation the art and science of the seaman, not the narrower part concerned only with finding position at sea.

The first steps in seafaring were made in pre-historic days and their nature is known only partly; if it is asked where, when and how sailed the first ship that navigated rivers or other enclosed waters or that one which first left the land and crossed the sea, the answer is ships were doing these things in the remotest antiquity our records reach; if asked when was first spread a sail or who first tacked a ship to work her to windward the answer is the same. Until men could build and use ships they lived isolated for the difficulty of land-travel was insurmountable; neither history nor geography began until after ships were in use.

The sea-art is among the oldest of arts and has served mankind mightily. It may be deemed its growth followed similar lines in different places even when there was no communication and this is proved by the records. Everywhere rafts and hollowed-out tree-trunks have been the ships first employed, and wherever rivers or the sea are men learned to build and use these; in which the first steps, the most difficult and calling for most time, were made before there was much contact among peoples. If as some believe sea-going craft were first built in Java the Javanese were unaided by people dwelling in other lands. The craft used in our day in Polynesia and on the coast of Africa Asia and parts of America are of a type once used by the Phenicians and Egyptians, from and through whom and through peoples of earlier days, have come the ships and sea-way we enjoy. The ships of the Egyptians when we first have account

of them, 5000 years ago, were however better than those now employed in Polynesia or Africa. There have been points of difference in developments in different places; a striking one is shown by remarks written 350 B C by Nearchus the admiral of Alexander the Great when he saw paddles used to propel boats.[1] He was near the coast west of the Indus, where harbors are few and vessels land through the surf for which paddles and not oars are suitable, while the craft he was embarked in, similar to those on the coasts of Greece where harbors abound, employed oars.[2] Neither rowing with oars nor paddling was used in smaller Japanese boats of modern day, but sculling with oars; which would appear to show advanced development for sculling is economical of power.

The words of John Locke above are not the only testimonial regarding the importance of the sea: the German historian Heeren writing of nations bordering the Mediterranean says, "The Mediterranean served as a medium of communication between the inhabitants of Europe Asia and Africa who beyond all doubt would have continued as uncivilized as those of central Asia if the basin of that sea had been a steppe like those of Mongolia." In another place he writes, "The first seats of commerce were also the first seats of civilization."[3] Laing a Scotchman in the introduction to his Heimskringla writing of the civilization of the Northmen in the Middle Ages[4] comments on the mistake of resting the state of the civilization of a people on the great edifices they build, pointing out that their seafaring, which requires development in many arts, is a better measure; and regarding the antiquity and universality of the art of the sea writes, "The *nave* of the Gothic cathedral with its rounded or pointed arches is the inside of a vessel with its timbers reversed and raised on posts. No working model for a Gothic fabric could be given that would not be a ship turned upside down and raised on pillars. The name of the main body of the Gothic church, the *nave navis* or *ship* of the building as it is called in all the northern languages of Gothic root, shows that the wooden structure of the shipbuilder has given the idea and principles to the architect." The American historian Prescott wrote in days when the seafaring of this country was the best in the world and many-fold more important

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1 Below p 10.

2 Ratzel Hist Mankind 3 vs for illustrations of ships of all places: also Admiral Paris' Essai sur la Constr Nav des Peuples Extra—Europeen; a superbly illustr volume; in N Y Public Library.

3 Pp XCVI, 469 v 1 Africa Hist Res Politics Eng trans: Heeren died 1842.

4 Heimskringla trans Laing London 1844 v 1 chap IV.

than now in regard to the sea-commerce of Barcelona,[5] "There is something in the atmosphere of the ocean that invigorates not only the physical but the moral energies of man. xx It was in the maritime cities scattered along the Mediterranean that the seeds of liberty both in ancient and modern times were planted and brought to maturity."

The people of America have turned their backs on the sea. Tyre a great and learned city for 25 centuries depended on ships and sailors,[6] as did in their day Carthage Athens Rome the mediæval cities of the Mediterranean Portugal Spain Holland England. All Powers reaching greatness have used the sea: the Empires of Athens and Rome depended on the sea; were nourished and supported by it: Pericles told the People of Athens 2500 years ago,[7] "Of vast consequence indeed is the dominion of the sea." Not far from the same date Plato wrote of the Greeks his countrymen,[8] "We xx inhabit only a part about the Mediterranean Sea like ants or frogs about a marsh;" and the Roman statesman Cicero wrote about 80 B C,[9] "Almost all of Peloponnesus lies on the sea. xx The islands of Greece surrounded by billows float as it were with the institutions and manners of their cities xxx." The speech of Pericles cited shows how clearly Athens' great statesman saw her dependence on the sea. The Roman Empire depended equally on it: a modern historian has written,[1] "The coasts of the Roman Empire may be computed at 13000 miles xx. Over this extensive coast the Empire was furnished with numerous seaports so that xx notwithstanding the great extent of its territory the distance of any place the most remote from the sea does not appear to exceed 200 miles. In forming this mighty dominion the Republic had united all the principal seats of industry then known in the western world had come into possession of all the seaports the most famous for ships and the residence of merchants who had conducted the carrying trade of the world." The empire of the followers of Mahomet, whose borders extended further than that of Rome, depended also upon sea power.

The speech of Pericles alluded to refers in terms to military power on the sea only, but the passage entire shows he understood this depends on the trading fleet. These matters have always been plain to those who

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[5] Ferd and Isabella v 1 p LXXXIII.
[6] Below pp 34–41.
[7] Below pp 114–15.
[8] Phædo Taylor trans p 229.
[9] Republic II 4.
[1] Ferguson Prog and Term of Rom Repub p 419 ed 1841.

give them attention: about 1300 years after the day of Pericles Offa King of Mercia in England 757 to 796 told his countrymen,[2] " He who will be secure on land must be supreme at sea." A hundred years later King Alfred added greatly to his ships making them,[3] " Full nigh twice as long as the others xx both swifter and steadier and also higher xx." Sir Walter Raleigh writes in about 1600,[4] " Whosoever commands the sea commands the trade, whosoever commands the trade of the world commands the riches of the world and consequently the world itself." Captains Ward and Mahan of our navy wrote of sea-power;[5] and to come to our own day many believe the Allies won the war lately ended by power at sea.

In more than one way facility at sea has accomplished great results: Laing writes in his Heimskringla,[6] " Two peoples only have left permanent impressions of their laws civil polity social arrangements spirit and character on the civilized communities of modern times, the Romans and the hand-full of northern people from the countries beyond the Elbe which never submitted to the Roman yoke xx. The history of modern civilization resolves itself in reality into the history of the moral influences of these 2 nations xx. Europe would have been like Russia or Turkey one vast den of slaves xx if 3 boats from the mouth of the Elbe had not landed at Ebbs-fleet in the Island of Thanet 1400 years ago and been followed by a succession of similar boat-expeditions of the same people, marauding conquering and settling during 600 years; viz from 449 to 1066 A D." We shall have much to say of the Northmen; their vessels made their way in early times not only to Britain but to the American continent and all parts of Europe.

The word ship occurs 35 times in the Old Testament [7] giving in many cases illustration of seafaring in ancient days. Among these are the words of Jacob of 1800 B C in regard to his sons as follows,[8] " Zebulon shall

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2 Saxon Chronicle Offa's reign. The words are not in eds accessible to me but are vouched for by Mr Hurd in an art called The Roy Navy and Bat of Horn Reef Contemporary Rev (Eng) July 1, 1916 p 1.

3 Anglo-Sax Chron Giles Bohn Anti Lib new ed 1914 p 63.

4 Judicious and Sel Ess and Obs, xx Raleigh; Disc on the First Inv of Ships London 1620 p 20. P 16 same v tells improvements in ships; they are fidded topmasts capable of being lowered chain bilge-pumps bonnets drablers studding-sails topgallant sails sprit-sails topsails weighing anchors by capstans lying at anchor with long scope of cable out etc. Many of these as will be shown were before Raleigh's day.

5 Nav Tactics Ward 1859 p 79.

6 Ed cited p 2 n 4 above; on p 5 v 1.

7 Young's Concordance; the places are given.

8 Genesis 49, 13.

dwell at the haven of the sea and he shall be for an haven of ships and his border shall be upon Zidon." The words denote organized sea-commerce.

TRADE ROUTES.

The ships that came to Zidon in 1800 B C hailed from Egypt Cyprus Crete and Asia Minor, crossing many miles of open sea. The ships of Tarshish that came to Tyre, the merchant of the people for many isles,[9] did this also. At the beginning of records ships from many places met at such emporia as the Tin Islands in Britain Cadiz Marseilles Carthage the port of Rome at the mouth of the Tiber the port of Athens Sidon Tyre the Nile-mouth in the west; and Pattala Champa Malacca Java Zayton in the east. Whether the ships of the east and west met we cannot be sure: Darius King of Persia 521–486 B C caused to be written on stones found in the route of the ancient Nile-Red Sea canal in recent day,[1] " Ships sailed from Egypt through the canal to Persia." About the same date ships manned by Phenicians passed down the Red Sea from Egypt rounded the Cape of Good Hope steering west and returned to Egypt by Gibraltar and the Mediterranean.[2] We hear of ships going by this canal much later, for the Irish monk Fidelis writes he passed by it from the Nile to the Red Sea in 825 A D; and while there are facts which may be held to disprove this these are not themselves unassailable. The question is curious but not very important and has been discussed by the French geographer Letronne.[3] There exists no mention of a ship in the canal later than the day of Dicuil.

It is certain that for long years before Da Gama rounded the Cape of Good Hope and reached India in 1498 the ships of the West and East had not been in each other's presence. Seamen and travellers passed frequently but ships did not. Da Gama wrote of the Moorish ships he met in the East, so he called them for the men in them were like the Moors of north-western Africa and with these Da Gama was familiar; and it is plain

[9] Below pp 37–38: it is generally believed Tarshish means Spain.

[1] Below pp 30–31 as to the canal and this inscription.

[2] P 30 below for Herodotus' words regarding this. What he says is all we know of the voyage. It has been much commented on: see Rennel's Geog System Herodotus. Upon returning the sailors reported they had the sun on their right when rounding the Cape; Herodotus says he does not believe this but seamen of Egypt had been far enough south a thousand years before his day to have the sun to the right when they faced west: also pp 39–40 below.

[3] Rech Geog et Crit sur le Livre De Mensura Orbis Terrae, Dicuil, p 9 and foll'g: see below p 280.

the ships were like his own and the methods of their pilots, their ways of navigating and the instruments they used, were like his and quite as good. This contact between seamen of the West and East is dealt with further on.[4] At earlier date we have proof of competency of seamen in the East: Marco Polo was in China 200 years before Da Gama passed the Cape and came home by way of Malacca to the head of the Persian Gulf in a Chinese ship. His Book shows he considered Chinese sailors ships and ways like those of Venice and the Mediterranean, speaking of charts used by Eastern seamen as he might of those in Western ships which he was familiar with.[5] Ships and sailors have always among people who have reached the same civilization been nearly the same. It has been asserted even that all Mediterranean seamen spoke the same language; a tongue composed of many others and understood only by themselves, but such characteristics are now levelled.

Those through whom we have inherited our ships and sea-ways we hear of first in the Mediterranean and on the coasts of Mesopotamia and India, though it is believed by some that seafaring in these districts came from further east, perhaps from Java or Polynesia. The art in the East remained stationary while that of the West advanced; the Greeks took the last over, made it their own and improved it and passed it west to Italy Catalonia and countries on the Ocean. The art of the Northmen meanwhile was advancing in circumstances very different from those surrounding the Greeks and Romans. The ships of the North did not enter the Mediterranean until about 800 A D, when Greek and Roman shipping had disappeared, and as the last rarely went in the Ocean the two probably never met. Yet as will appear [6] the Northmen's ships and sea-ways were like those of Greeks and Romans.

THE FIRST WATER CRAFT AND EARLY DEVELOPMENT.

When men acquired stone-cutting implements they began to build ships to procure fish for food and to transport persons and goods and then began that dissemination over the earth which has peopled every part of it. The craft were probably rafts but before considerable movement took

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4 Pp 25–6, 245–7.

5 Cordier's Yule's Marco Polo v 2 pp 312, 424. In the place first cited Polo tells the number of islands near Ceylon, "As you will find in the charts of the mariners of those seas;" in the second he writes, "According to the charts and documents of experienced mariners who navigate that Indian Sea."

6 Pp 274 and near-by and 17–19.

place these were replaced by vessels formed from trunks of trees hollowed out by cutting tools and fire; dug-outs we call them. These are among the most enduring of appliances for they are still made in the same manner as thousands of years ago. In dug-outs men sailed and still sail not only on rivers but on the sea as well, performing voyages with many persons and their baggage.[7] Seafaring becomes competent when trade is developed, for then ships do not follow coast lines as they find them but go to a defined place and return.

Large bodies of men with their women children and baggage have been conveyed often in ships in a search for better habitations. At times they knew whither they were bound and at others wandered at random having been forced to leave their former dwelling place. The landings from such fleets were frequent, for dug-outs are not sea-keeping and life cannot be supported aboard them for long. By such voyages and by expeditions of piratical character knowledge of geography was begun and the foundation of over-sea trading laid. Men have never voluntarily set out in unknown seas without care to a supply of water and food to enable them to return; though extension of trade and peoples has often been furthered by a ship blown away across waters of which nothing was known, if the people in her lived and returned to tell their story.[8] All such voyages in rafts or dug-outs were broken by frequent landings for sleeping cooking and eating procuring food and water and the like.

Organized seafaring and trade can extend only as knowledge of the situation and shape of seas and lands progresses and thus growth has been slow. With the love of adventure and pure daring it was the desire to find lucrative places of trade that urged men over-seas. The map of the earth was drawn as ships seeking ever further for trade extended their voyages. Geography grew slowly in the wake of trading over-seas until the voyages of Dias Magellan and Columbus doubled, quadrupled perhaps, the size of the known earth by giving the approximate situation of the continent of America and of those great outer promontories, the Cape of Good Hope and Cape Horn. The term approximate is not used at random, for not until 300 years after the day of Dias and Magellan did it become possible to determine longitude; as necessary as latitude in fixing position. Maps could not be right and seamen could not know where their

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[7] Northern Mists Nansen Eng trans v 1 p 22: Civilization Sweden in Anc Times Montelius p 27.

[8] Columbus is said to have learned the position of land on the far side of the Western Ocean in this way: see below pp 545–49.

ships were until they could determine both latitude and longitude; but until 300 years after the day of the Great Ocean Voyages, longitude on either land or sea could rarely be determined otherwise than by dead-reckoning. A ship keeps record of her course and the distance she passes over, or a man does the same on the land as he passes along, and by the aid of a table [9] learns how far north or south and east or west they have gone. Ships sailed all over the earth in the 3 or 4 hundred years after the Great Voyages and from their logs maps were made in the manner outlined. It was close to the year 1800 before chronometers and tables giving the position of heavenly bodies relegated that ages'-old process called dead-reckoning to its present less important use; but because making maps of large areas is matter of complication these remained inaccurate until long after.[1] To cover small areas maps can be made by triangulation, by covering the area with interlocked triangles; a method practised by the ancient Egyptians. Such maps are accurate but if the area is large and includes an arm of the sea across which an observer cannot see to establish a triangle the method fails.

STEPS IN THE BETTERMENT OF SHIPS.

Great dug-outs have been raised from the mud in which they were embedded for thousands of years.[2] As cutting-tools improved and the use of metals, copper bronze and iron, was acquired dug-outs grew better and were more and more built-up. Built-up craft require less labor in construction and are lighter and of more carrying power than dug-outs. It would be perceived that built-up vessels could carry more and be more easily urged through the water than vessels built from the trunks of trees and they would be employed for these reasons. These long low vessels partly

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[9] Called *traverse table:* at the top of each page is an angle, the course of the ship or man; in columns are 3 quantities, the distance gone and changes of latitude and longitude corresponding. From the table knowing how far the ship or man has gone and the course the change in latitude and longitude are taken; it gives the sides and angles of right-angled triangles of all shapes.

[1] Below pp 625, 649 and foll'g as to longitude and chronometers. De Ruiter testifies to the inaccuracy of maps in his time: he made 2 voyages across the Atlantic in 1641 and his biographer writes, "He discovered many errors in the ordinary charts and always entered his observations in his journal. In 2 voyages to Brazil and the Antilles he found they were about 130 leagues further east than the charts showed"; p 6 French trans Brandt's de Ruiter Amsterdam 1698. A chart with coast line 400 miles out is not much better than no chart. The error is 1/9 in excess: charts of the Mediterranean of the same date made it too long by 1/3; see below p 41 n 1.

[2] Prehist Antiq Aryan Peoples Schrader Eng trans p 367.

dug-out and partly built-up are still used in many places, and in certain regions have been improved by fitting them with sails, with a hut placed on the deck for the crew and passengers to live in, planks laid along the rail to make them drier and more seaworthy, and addition of awnings.[3] While it is probable some river craft did not use sails no ships can have gone on the sea without adopting these, and Ratzel's illustrations show that on the sea men use sails when in primitive state. On the Nile a great artery of trade in remote antiquity sails must be very old for the steady seasonal wind there prevailing is too obvious to suppose it was not employed. The ships of the Northmen, probably developed within the fringe of islands which skirt the Scandinavian peninsula on the side of the ocean, were perhaps at first without sails for in narrow or crooked waters subject to calms and squalls sails are of little use.[4] But when these began to make runs outside it is impossible they rowed before a breeze and following the sea, for if the men stood up and spread their shirts the vessel would go faster than oars could urge her. Polynesian craft if developed where the Polynesians live now must always have used sails, for the monsoon or trade-wind could not be overlooked and there are in Polynesia no rivers or narrow crooked waters surrounded by high knolls, causing calms and squalls.

There are interesting features of a very general character connected with the early history of ships. In one author we read,[5] "The Indo-Europeans before their dispersion were not in contact with the sea.xx There are only 2 things in the matter of seafaring which have identical names in Asia and Europe, they are rowing and that which was rowed, the boat. It is in the European languages that a uniform designation is to be found first for another portion of the ship, the mast. For the rest, here too there is a great divergence in the names of such things as sail yard anchor helm keel. As a rule fishing appears in close conjunction with seafaring; xx in the vocabulary of the original Indo-European language there is neither a collective term for the general notion of fish nor an individual name for any kind of fish. Nor can primitive names for the direction of the winds be discovered." Mommsen lends his authority to this, making these statements;[6] "In their original dwelling-place the

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3 Ratzel Hist Mankind Eng trans 3 vs for illustrations.

4 Civil Sweden Montelius pp 73–5; in records of Bronze Age 1500 to 500 B C, "No indisputable traces of masts and sails have been found on the rock-carvings."

5 Schrader cited note 2 p 8 above, p 353.

6 Hist Rome Dickson trans v 1 p 23.

Indo-Europeans had a word for a boat and for the means by which these were propelled, paddles or oars": the addition of a word for sailing-vessel came after the forefathers of the Greeks and Romans separated; after they had broken off from the great common family and come down into the peninsulas of Greece and Italy.

Thus when the Greeks and Romans reached the peninsulas they were to occupy they saw the sea for the first time. They found trading-ships driven by sails in the hands of Egyptians Phenicians and perhaps others. This was about 2000 B C; the subject will be returned to later.[7] The paddle was probably used before the oar, though perhaps each belongs in its own surroundings. The paddle is simple and almost necessary in handling boats in broken water or surf and thus convenient where waves roll into landing places or in rapids in rivers; while the oar less convenient in such waters has the advantage that its weight rests on the thole and is thus less fatiguing in use. Nearchus sent by Alexander the Great from the mouth of the Indus to the head of the Persian Gulf in 350 B C wrote about the use of paddles by the natives,[8] "Boats not rowed with oars over the side according to the Grecian manner but with paddles which they thrust into the water as diggers do their spades into the earth." Vessels of primitive construction may still be seen and we have co-temporary pictures of Greek Phenician and Egyptian vessels of several thousand years ago; some use paddles and some oars.[9]

LONG-SHIPS AND ROUND-SHIPS.

It was a great epoch when a dug-out first put out from shore. A second great date was made when a built-up craft of similar general appearance but ornamented with raised bow and stern put off. These came to be called *long-ships* and this name is used until about 1700 A D; until the day of the great ocean voyages is long gone and that of Ruiter and Duquesne Tourville and Rooke as well. They were long lean craft with little beam very low in the water [1] unfitted for use in the ocean or long stay at sea. We criticize them because bound to the land and smooth water but they were

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[7] P 32.

[8] Arrian's Hist Alex trans Rooke 2 vs, Voy Nearchus Ch 27 p 255. Nearchus wrote a log of his voyage; below pp 39 and 49: in it he writes of what we call spar-buoys.

[9] Below pp 20–30 as to Egyptian and 33 Phenician ships.

[1] They possessed similar qualities throughout their long life and are well described when near their ending by one who sailed in them in Mem d'un Protestant Condamne aux Galeres, xx written about 1710 A D; see below, pp 514 and 499.

used in the Mediterranean for more than 3000 years and served their purpose. Built-up long-ships, because their hulls are lighter if of the same floating capacity, are better freighters than dug-outs. All these vessels were in early days without decks but about 500 B C when written records begin decks were in use. The greatest epoch came when the sailing freight-ship sailed on her first voyage. These from the earliest were called *round-ships*, being a development from the built-up long-ship and wider deeper and more heavily built. Many of them were larger, of greater floating power, than long-ships; and while using oars on special occasions they depended much on sails. The over-seas cargo-carrier has been among the very great promoters of progress, having only one rival in the good she has done; the wagon wheel. At the dawn of record we find both in their places; but before wagons could have carried weights for distances ships as their roads were ready were doing this. The same is true of pack-animals; the ship driven by the wind was long without rival in the field of transportation. It was impossible when there were no roads and wide spaces were uncleared and journeys traversed territory occupied by unknown tribes often hostile to go otherwise than by sea. We have many records in ancient days of travel by sea; all men of wealth and position travelled and all went in part at least by sea. There is a curious proof of the ease of sea-travel in inscriptions carved on stone by Assurbanipal King of Nineveh 650 B C: on stones found in Nineveh Assurbanipal had carved, "Gyges King of Lydia a district which is across the sea, a remote place." There is little difference between the distance from Nineveh by land to Lydia and that by ship from Phenicia to the south shore of Asia Minor and thence to Lydia; but to the people of Nineveh the sea-route was the only one known.[2]

The round-ship came after the long-ship; but the latter remained in use for war and as passenger-carriers. She required many to row her and was costly in operation. By the day of the Greek Empire she was decked, partly to provide storing place where things could be kept dry and partly because used as a ram in battle, and a deck greatly strengthens a ram-vessel. The round-ship when she reached respectable dimensions was decked and soon had more decks than one. Her *sea-keeping* power as we say was the same as that of modern sailing-ships, almost unlimited. For the men she carried the food and water necessary for months hardly

[2] Hist Assurbanipal from Cuneiform Inscr Smith pp 64, 71, 73: pp 75, 77 will be found names of directions; points of the compass we now say.

detracted from cargo-space. From the first and until her disappearance about 1750 A D the long-ship clung to the land, making short runs from port to port when the weather was good and lying in port when it was bad and usually over-night. The round-ship struck out straight for her port. She did this from the time she was first built and continued always to do it. The fact that long-ships clung to the land and the others struck out over-seas is to be read in the characteristics of the ships and many circumstances bearing it out are in histories.

EARLY RECORDS OF SHIPS AND SEAFARING.

There are ships carved on the stones of Egypt of date 2500 B C.[3] Some are long- and some round-ships; back of the day of these vessels, back that is of 4500 years ago, for another period of equal length there is indication of traffic by sea.[4] That is there is indication of over-seas commerce 9000 years ago, the vessels being round-ships and on the high seas. The first ships we hear of had already been thousands of years in growing. It is coming forward many years to the day of the Greek poet Hesiod, for his date was 800 B C; but he left a few words which show ocean traffic was understood in his day; "Praise thou the small vessel," he says,[5] "but place thy goods in a large. Greater the cargo the greater the gain upon gain will be provided the winds refrain from their evil blasts." By Hesiod's day the Greeks had been operating round-ships for a thousand years. The ships of 2500 B C on stones in Egypt are traders propelled by sails. Some long-ships of early day were more than 100 feet long and capable of carrying 100 or more men and long-ships now in use by primitive peoples are as large. A number of ancient vessels have been found and recovered, an Egyptian boat of 1800 B C among others.[6] This is a long-ship 8 or 10 times as long as broad. Sailing-ships of not long since like round-ships of old were 3 or 4 times as long as broad. Noah's Ark was 450 feet long by 75 beam by 45 deep;[7] here the ratio of length to beam is 6 to 1. The appearance of ancient long-ships was like that of the long straight craft now used in many places, to propel which oars or paddles are employed, and that of round-ships the same as junks still used in the

[3] Below pp 26–30.
[4] Below pp 14 etc.
[5] Hesiod Banks prose trans Bohn p 110.
[6] Below p 29.
[7] Genesis 6, 15; the date is about 2500 B C: Torr's Anc Ships pp 22–30.

Far East.[8] Like the last the round-ship was heavy-built high out of the water broad and drawing a good deal and had one mast and one sail on this. This sail had usually a yard at its top only and it could not stand flat.[9] It was a square sail. The sails of long-ships were fore-and-aft, what we call lateen-sails. The size of ancient round-ships would put them in a class rating as much as 200 to 400 tons of our measurement and vessels of this size remain numerous until our day.[1] Though sailing trading-ships have been of nearly the same size as a rule their masting and rigging has changed wholly and they are now much more capable than formerly. This change has been of simple character though centuries in growing; being in the way of breaking sail-area up into many parts. For centuries round-ships had one mast and one sail on this: now they have 3 or more masts several sails on each and are provided besides with many flying kites, studding-sails stay-sails etc.

The distinction between long- and round-ships is brought out well by the following words of Herodotus,[2] "The Phæacians were the first of the Greeks who performed long voyages. The vessel which they used was not the round-built merchant-ship but the long penteconter." The penteconter pulled 25 oars in one horizontal line on each side, 50 oars in all. Herodotus is referring to Greek over-seas colonization 400 years before his date. The Phæacians were exploring and had little knowledge of the sea they were in, in which circumstances they learned how it would be best to steer—near Sardinia Corsica Marseilles where their ships were—by enquiring onshore. On such service penteconters were more convenient than round-built sailing-ships. In another place Herodotus writes,[3] "All ships in these early times were painted with vermilion and that was what

8 Yule writes Cathay and the Way Thither 2 vs, v 2 p 417, "Junk is certainly the Malay and Javanese *jong* or *ajong*, a great ship."

9 The sails of no craft stand flatter than those of small Chinese vessels. They have bamboo sticks parallel to the boom sewed to the sail, but their large vessels do not use these.

1 A British Admiral wrote about 1780 A D; "The bulk of our over-sea trade is in fact conducted in vessels of from 200 to 400 tons"; Letters Hood Navy Rec Soc p xxii.

2 Bk 1, 163. His date is 450 B C. See below p 67 for Homer about guidance of ships of the Phæacians. See p 197 below.

3 Bk 3, 58. A note to this in Rawlinson's Herod reads, "Yet Homer almost invariably writes of black ships. Perhaps though there is no contradiction, for Homer's ships are *crimson-cheeked* or *vermilion-cheeked*. It would seem that while the hull of the vessel was in the main black being probably covered with pitch or some similar substance the sides above water which Homer calls the cheeks of the ship were red. Herodotus may mean no more than this."

the Pythoness means when she told them to beware of danger, 'From a wooden host and a herald in scarlet.'"

There is in the Book of Proverbs and of date about 1000 B C a passage showing round-ships carried cargoes far. It is in a description of a good house-wife and reads,[4] "She is like the merchants'-ships she bringeth her food from afar." In and about the land we call Syria over-sea trade was far advanced when this was written. Perhaps the Hebrew word rendered merchants'-ships might be rendered round-ships and so bring the language closer to Greek phraseology;[5] or perhaps great-ships and so bring it closer to junk [6] used in the East for freight-carriers.

SEAPORTS.

The use of ships leads to growth of ports and the story of these has remained better than that of ships. The city of Patala the modern Hyderabad the capital of Sindh was the seaport of the Shus who, a modern author writes,[7] "Were a conquering and trading people of India in very early days." Our authority goes on to show by the rate at which rivers near-by have formed land seaward by silt brought down, and because Patala is now 115 miles from the sea, that its origin was about 7000 B C. Perhaps few will be disposed to accept so great an antiquity but a robust faith is necessary in reaching a conception of ancient days and as the history of ancient times has been revealed parts of the records formerly disbelieved are accepted. Patala is not the only port of ancient times of which we have record. We read that Abram and Sarai his wife,[8] "Went forth from Ur of the Chaldees." The date is about 2250 B C and the passage implies that Ur was not then a new city. A modern author writes respecting Mesopotamia,[9] "It was only at its southern extremity that Mesopotamia had a seaboard but there seems no doubt it held communication with India by sea. Ur the oldest of the successive capitals of Chaldæa was near the Persian Gulf and its ships are often mentioned in the inscriptions. xx That communication between the 2 countries existed can be proved. xx The zebu or humped-ox is often represented in Mesopotamian

[4] Ch 31, 14.

[5] Below next p n 4.

[6] Above p 13 n 8.

[7] Hewitt Ruling Races in Pre-historic Times p 140.

[8] Genesis 11, 31: the oldest emporium of Phenicia Sidon seems to have been before Ur; see 10, 1–6; Canaan the grandson of Noah, "Begot Sidon his first-born."

[9] Hist Art Chaldæa and Assyria Perrot and Chipiez Eng trans v 2 p 378.

monuments, and the animal is indigenous in India. xx Among the half-decomposed beams in the ruins of the Tower of Chaldæa some of teak have been recognized. Now the home of this tree is in India, it is to be found neither in Chaldæa nor in any other part of western Asia." Ur is thus shown to have been a port by 3000 B C; it had long life as such, as long probably as that of Tyre, for the Prophet Isaiah writes about 700 B C of,[1] "The Chaldæans whose cry is the ships." Ur must have remained a place of importance at least until 500 B C, for in that time Darius conquered and annexed the sea-commerce west of the Indus [2] which makes it a seaport for 2500 years.

LONG- AND ROUND-SHIPS AGAIN.[3]

The Greeks called long-ships and round-ships *makrai naus* and *stroggulai naus*, of which long-ship and round-ship are the translation.[4] Of the former we have much account for they were employed in wars and in conveying great personages to and fro on their occasions, but of round-ships little is recorded and it is not easy to learn about them. As now the long-ship, war-ship, was in continual change; though since she continued always the same as respects sea-going qualities the changes were more in appearance than reality; and again as now the freighter grew slowly larger and her masting and rigging improved.[5] There were wide differences in handling the 2 types of ships. The round-ship was not run aground on entering port but anchored off while business was transacted by little boats, or where such conveniences existed went alongside a wharf. The long-ship if she was to stay a short while dropped an anchor off from the beach and running a rope to the shore lay with her head to her anchor and stern in shoal water near the beach so her crew could

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1 Ch 43, 14.

2 He, "Made use of the sea in those parts"; below p 39.

3 Above pp 10 and foll'g.

4 In the Greek ed of Blakesley's Herodotus will be found bk 3, 135 the word *olkada* usually translated merchant-ship, and bk 3, 136 and 137 the word *gaulon,* also translated merchant-ship. There is in this Greek edition a foot-note to *gaulon* as follows, "This word appears to be the Phenician word for a merchant-ship. It is derived by Bochart from the Hebrew root *gol,* round. The term is therefore the exact equivalent of the Greek term *naus stroggule.*" It would be satisfactory to show that Hebrews Greeks and Malays used terms really identical for freight-carrying ships; but this must be left for those learned in these languages. In Liddell and Scott's Greek Lexicon word *gaulon* will be found relation of this word to the Sanskrit; see also note p 431 v 2 Rawlinson's Herodotus.

5 The difference in going by long-ship and round-ship is told in Von Suchem's Desc of Holy Land written 1350; p 287 below.

land by jumping overboard or by the landing-ladder. A ladder over the ship's side has been used from very early date: in the Odyssey we read, "The crew bound me closely with a twisted rope and themselves went onshore and hasted to take supper by the sea-banks. Meanwhile the gods themselves lightly unclasped my bands and xx I slid down the smooth ladder at the stern." The use of the ladder and the fact the crew landed for a meal should be noted. Because filled with oarsmen without means of cooking with no room for the men to recline people in long-ships landed for meals and to sleep. Pilots knew not only the seas and coasts but where smooth landing beaches were to be found near which it was necessary to have drinking-water for the capacity of a long-ship for water was small and consumption high. The round-ship was the opposite of this. Like sailing-ships of all time she was sufficient to herself for long periods and like her feared nothing so much as the land. She got a good offing and steered for her port avoiding intermediate islands. It has never been worth while to load small weight into large ships for short runs and so light cargoes in olden days often went by long-ships manned with a part crew.[6]

The ways of long-ships are thus described by Homer,[7] "When they were now entered within the deep haven they furled their sails and laid them in the black ships and lowered the mast by the fore-stay and brought it to the crutch with speed, and rowed her with oars to the anchorage. Then they cast out mooring-stones and made fast the hawsers and so themselves went forth on the sea-beach. xx And when the sun went down and darkness came upon them they laid them to sleep beside the ships' hawsers, and when the rosy-fingered dawn appeared the child of morning then they xx set up their mast and spread the white sail forth. So when they were now come to the wide camp of the Achæans they drew up their black ships to land high on the sands and set in line the long props beneath them and themselves scattered amid their huts and ships." A little further on, "And the assembly swayed like high sea-waves xx. And they bade each man his neighbor to seize the ships and drag them into the bright salt sea and they cleared out the launching-ways and the noise went up to heaven of their hurrying homewards and they began to take the props from beneath the ships." In the first passage the ships stop first for a night only and afterwards for longer and in the second the crews embark after the ships have been onshore some time. The mention of huts should be noted, for

[6] Below p 72.

[7] Prose trans Iliad Lang Leaf and Myers 1883 pp 15–6, 25.

because of the impossibility of living in long-ships more than a few days tents or huts in which to live onshore were carried. There is an interesting passage in an author who lived 500 years after Homer; the poet Æschylus, he fought in a Greek ship at Salamis in 480. In his Suppliants he writes,[8] "No speedy task the manage of a fleet nor yet to fix its moorings nor ashore safely to bring the stern-ropes."[9] It should be noted in regard to mooring vessels parallel to each other and perpendicular to the beach that the Mediterranean is almost tide-less and current-less.

Greek vessels of war were hauled onshore stern first probably so they could put off and away quickly if attacked. Present day vessels could not be thus hauled on the land because of the angular shape of their stern, the heel as it is called, but ancient vessels being rounded at the stern[1] came to the beach and discharged their men. So quickly could they embark or disembark that not infrequently part of a battle was afloat and part onshore. At Marathon the Greeks drove the Persians to their ships moored at the shore and fought with them while the Persians got into their ships as cavalry might mount their horses.

THE NORTHMEN AND PEOPLES OF FAR EAST.

Ships passed to and fro in the Mediterranean the Persian Gulf the sea between Arabia and India and down the east coast of Africa southward at early period. There was seafaring in other parts of the earth as well in most cases independently developed but such developments nowhere grew as in the Mediterranean and Persian Gulf. Next to the forebears of our own seamen those who have accomplished most are Scandinavians and people of the Far East. The former were the first to cross the Atlantic their ships going and returning regularly from about 900 A D onward, going by the Faroes Iceland and Greenland; which islands it was necessary to happen on before they could be used on the way from Norway to Greenland. Earlier than 900 A D the Northmen cruised along the Atlantic coast of Europe to the east end of the Mediterranean and to the islands in the Atlantic off the west coast of Africa. They reached a point well south in the coast of America in voyages from Greenland. Peoples of the Far East have done wonderful things. They spread themselves and their

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[8] See p 173 n 6 where this is more completely given; and p 173 for another case of landing.

[9] See below pp 199–200 for management of round-ships in harbor in 200 B C.

[1] See illustr Athenian triere end v 1 Serre's Mar de Guerre; and fig 78 p 104 Cartault's Triere Athen.

language from the Island of Madagascar east to Easter Island off the west coast of South America, from longitude 40° E from Greenwich to 112° W; and from New Zealand to Hawaii, latitude 47° S to 22° N; in all over more than 200° in longitude and 70° in latitude. If Polynesian territory were one state it would be the largest in the world. When and how this was done we do not know but as the Polynesians use now what we call "canoes" these must have been employed; unless as believed by some they formerly had better ships.[2] The people of China Java and India had also capable shipping in early times.

The ships of the Northmen penetrated the waters of Europe wherever a keel can go before 800 A D. Their ships were more sea-worthy than those in the Mediterranean having been developed in the gales and big seas of the North Atlantic, but they did not replace the long straight low long-ship of the Mediterranean; these continued to be used making occasional voyages into the Atlantic for a thousand years after ships of the north came there. Before 900 Northern ships crossed to Greenland in the fogs and gales and again later beginning about 1100 A D there were many in the Crusades making the run from home to the coast of Syria with safety and certainty. Here they were in company with ships of other nations, but though we have histories written by men in the ships none refer to differences between vessels of the Mediterranean and the North or to devices or improvements taken one from the other. These writers were not professional seamen but churchmen or gentlemen of the retinue of the leader of the expedition.[3]

Between Far Eastern seafaring and that of the Mediterranean contact was early but not frequent. Ships built at the head of the Red Sea by King Solomon and Hiram of Tyre went to the East about 1000 B C where they may have encountered ships of Java China or other places. Ships built in the Persian Gulf went to China it is said by 675 B C and Chinese

[2] Almost any book regarding remote times deals with seafaring; Ratzel's Hist Mankind is perhaps the best. See also Early Hist New Zealand Sherrin and Wallace; Polyn Resear and Hist Madagascar both by Ellis; Grandidier's 2 works on Madagascar; Early Migrations of Japan Wrecks xx in N Pacific Brooks; Hist Gen des Races Humains Quatrefages (this gives track-chart of migrations of Polynesians in the Pac); Montelius' 2 works on anc Scandinavia; Northern Mists and Eskimo Life both by Nansen and both trans into Eng. Eskimo Life tells of a seafaring independently developed admirable and wonderful; the little craft into which the whale hunters are each one lashed can be righted when capsized if hold on the double paddle is not lost.

[3] Keary Vikings in Westr Christendom p 109 regarding voyages of Northmen. See below pp 402 and 410 as to ships' crusading operations.

Viking ship of about 850 A D; taken from frontispiece of Nicolaysen's work, for which see p 398 below.

ships came to the head of the Red Sea and Persian Gulf by the beginning of the Christian era.[4] The Arabs and Phenicians races nearly akin followed the sea longer and accomplished more than any other people. We hear of them as seafarers 1000 years before the Christian era and when Da Gama came to the East about 1500 he and those who followed him destroyed this peaceful traffic replacing it by a monopoly supported by armed force. The seafaring of the Arabs was the equal of that of Portugal; it may indeed have been superior for among the Arabs long voyages were common but unusual for Portuguese and other Europeans.[5]

THE MAHOMETANS AND EASTERN PEOPLES.

The Arabs Saracens Mahometans, however we are to call them, preserved the learning and culture of Europe during the Dark Ages. They introduced or developed instruments and methods of calculating used in position-finding at sea and brought us the compass.[6] No history of seafaring can exclude the Arabs, nor may the Polynesians or Chinese be passed over, for the last reached the West by the beginning of the Christian era, and the Polynesians though not in contact with the West until after 1500 A D are too good sailors not to find mention. When Magellan reached the islands of the Pacific 400 years ago and first of Europeans his men saw the *proa*, the long-ship of Polynesia, they seemed to them to fly, so fast they went and so close to the wind. Pigafetta who chronicled the events of the voyage wrote,[7] "They make the stern bow and the bow stern."[8] Magellan found round- as well as long-ships in the Far East. When near Borneo Pigafetta wrote in his journal,[9] "Junks are their ships xx. One of these junks carries as much cargo as a ship." The ships

[4] See (1) p 35 below the ships of Solomon and Hiram; (2) p 25 statement of Lacouperie and inscrip of Sennacherib; (3) Hirth China and the Rom Orient Researches xx in Old Chinese Records Shanghai 1885; also above p 10 Voy Nearchus.

[5] Below pp 233–48.

[6] Sedillot Instr Naut des Arabs and Hist des Arabes; Orig Pass on Early Com of Arabs Sprenger in Jour As Soc Bengal v 13 pt 2, 1844 p 519; Die Top Cap des Indischen Seespiegels Mohit Bittner mit einer xx Tomaschek Vienna 1897. As to compass see Klaproth Boussole p 65.

[7] Magellan's Voy Robertson v 1 p 95.

[8] The proa does not come into the wind and beyond when she tacks. By the helm her stern is brought to the wind the sail shifted and she goes on on the other tack: the same side is always to windward, and on this side is an outrigger on which men run out when the wind comes strong. She is the fastest and most weatherly craft ever devised but being very wet would not serve in a cold climate: see below p 667 for what Dampier wrote of her about 1700.

[9] Mag Voy Robertson v 2 p 39.

of the East and West after a period of great but unknown length met in 1500 A D and were alike.

A particular circumstance regarding the Polynesians must be recorded: in Easter Island Tonga the Carolines and Ladrones are massive ruins. In Tonga is a monument consisting of blocks of stone 40 feet high surmounted by a slab lying across and there are similar remains in the other places named. The stones were brought by sea for they are not from the islands themselves but there is no trace nor tradition how they came nor what the edifices represent.[1] Because of these ruins and for other reasons many have thought there were in the East at a period long passed ships better than those now found. The location of these islands is as follows: Easter Island is 1800 miles west of South America with no intermediate islands and 8000 miles E S E from Java, the place from which Polynesian migration probably set out; Tonga is 3600 miles west of Easter Island; the Carolines 2800 miles north-west of Tonga; and the Ladrones 1000 north of the Carolines. There are intermediate islands after passing Easter Island. It is generally believed the Polynesians spread eastward, against the direction of the trade wind.

PICTURES OF ANCIENT SHIPS.

In examining actual vessels of primitive peoples or pictures of these we may be sure we are examining craft coming close to those used in the Mediterranean 3000 years ago. We must avoid the conclusion that primitive long-ships are like those Greek long-ships which used oars at more than one level, if such vessels existed, for long-ships of our day use only one horizontal tier of oars:[2] in the same way in sailing-freighters in the East of our day we see the early round-ship of Europe. Of a ship our oldest illustration is in Egypt of date 2750 B C and there is one in Java of a Malayan or Javanese ship of the 8th or 9th century A D.[3] The vessels shown are very like each other and like the junks of China and Japan of our day. The Egyptian ships are those of Sahure and belong in 2750 B C; the Malay or Javanese ship is on the Buddhist temple of Boro-Boudour in Java and belongs in the 8th or 9th century A D: the ship of Egypt is 3500 years the older.

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[1] Ratzel Hist Mankind v 2 p 161; Ellis Polyn Researches 4 vs.

[2] Above p 13 for penteconter; below pp 72, 74, and foll'g in regard to oars at several levels.

[3] Below p 26 as to the Egyptian and pp 261 and foll'g as to Javanese ship.

After the Boro-Boudour ship I know of no interesting illustration of a large round-ship until that of a Chinese vessel of before the year 1400 A D.[4] This has 3 masts each with one square sail and is crossing the sea from Ceylon to Java. The constellation of the Dipper is shown on her port beam the Southern Cross on her starboard beam and a constellation called Pu-ssu on both port and starboard quarter. In the article where this is found there are 2 sea-charts of Chinese origin[5] of about 1400 A D of larger scale than European charts of the date which have been preserved. They show the sea near Malacca and while there is no scale nor compass on them their accuracy may be examined by the distances between easily identified islands and bearings between these. It results from such examination that the charts are inaccurate in distances and bearings. There is on p 33 of the publication mentioned the log of a ship going from Canton to India written during the Sung period; 960 to 1278 A D.

SEAFARING NEAR THE RED SEA AND PERSIAN GULF: VERY OLD CHARTS.

We leave the Far East and return to Syria and Mesopotamia. There is in the Louvre in Paris a statue of Gudea a King of Lagash on the Persian Gulf which was found there and on it is inscribed that the stone was brought from the mines at Sinai; down the Red Sea and up the east coast of Arabia. Gudea was King before 3000 B C. On the lap of the figure is a stone on which is carved a map and to the map is added a scale for measuring.[6] Here we have a map complete with scale more than 5000 years old; it is probably of a land area. Many years later, about 1500 B C, we read in the Book of Joshua how such maps were made: Joshua commanded his servants,[7] "Go and walk through the land and describe it and come again to me xx. And the men went and passed through the land and described it by cities into 7 parts in a book and came

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[4] There are pictures of ships on maps; see the Catalan Map of 1375 plt 3 for 5-masted Chinese ship. See p 302 as to Catalan Map. See also pictures pp 4 and 17 above.

[5] Seaports of India and Ceylon xx with Acct Chinese Nav; 2 articles by Phillips in Jour China Br Roy As Soc 1885 and 86 new series vv 20 and 22. See also a Chinese seafaring ditty belonging in about the day of this chart and its trans into Eng p 277 v 2 Cordier's Yule's Marco Polo. Fei-Hsin to whom we owe this song is stated in Giles' Biog Dict to be, "Author of an acct of 4 voy made in the Indian Ocean in early part of 15th century." The ditty is given p 263 below.

[6] Hibbert Lect 1887 Sayce Origin and Growth Religion pp 30, 34, 66–7, 136—7: Kennedy Early Com Babyl with India p 241 Jour Roy As Soc new ser v 30, 1898: p 341 Nature v 28, 1883 Petrie Earliest Known Plotting Scale.

[7] Chap 18, 8 and 9: see below p 260.

again to Joshua to the host at Shiloh." The men measured distances and angles and no doubt a good map was made. Later the Prophet Ezekiel alludes to a map in these words, the date would be about 600 B C;[8] "Take thee a tile and lay it before thee and pourtray upon it the city xx. And lay siege against it and build a fort against it and set battering rams against it round about." The word *pourtray* should be noted, for it indicates a drawn or painted map not a written description. There is in the Bible a description of a map in the day of Abraham 500 years earlier that Joshua. It reads,[9] "And the Lord said unto Abram after that Lot was separated from him, lift up now thine eyes and look from the place where thou art northward and southward and eastward and westward. For all the land which thou seest to thee will I give it xx. Arise walk through the land in the length of it and in the breadth of it for I will give it unto thee." It should be noted the points of the compass are mentioned. The date is about 2000 B C.[1] This with two others of about the same date are the first occurrence of the names of directions in the Bible.

Somewhat later we find in Herodotus description of a survey over water. Darius King of Persia 521–485 and his wife Atossa discuss whether the army shall conquer Scythia or Greece first and the decision was for the last; to all appearance because Atossa wishes to have Greek maidens of whom she has heard much to wait on her. As maps of the coasts of Greece are needed the business is put in trustworthy hands and ships fitted; these,[2] "Set sail for Greece, when they had made the land they kept along the shore and examined it taking notes of all they saw."[3] We must call on our imagination to comprehend the operations of the surveying party; no doubt it included men to measure angles and distances and portray these on a parchment or other surface; if indeed the seaman did not do this. The ships sailed over the area as Abraham and the servants of Joshua walked, and described it in a book portraying it as a chart afterward. Herodotus tells [x] of a chart brought the King of Sparta by one Aristagoras about 500 B C; it was he says a, "Bronze tablet whereupon the whole circuit of the earth was engraved with all its seas and rivers":

8 Chap 4, 1–2.

9 Genesis 13, 14–17.

1 Genesis 11, 2; 12, 9.

2 Herod bk 3, 136. Herod wrote about 450 B C.

3 Below p 260 as to map-making.

x Bk 5, 49.

having it before him Aristagoras points out the situation and boundaries of seas and countries lying between Greece and Persia.

Maps were made when geography made its first beginnings; before men began to go to lands other than their own *and return.* That we have no written account of a chart of a sea-area until about 500 B C when Darius ordered one made is not material, for when lives and property of great value were embarked for a voyage everything tending to safety was employed; Chaldæan ships plying between Ur and the head of the Red Sea and coasts of India and Africa in 3000 B C, those going out and back from Sidon at the same date, and the merchants'-ships the Book of Proverbs says brought food from afar, none wandered at random.[4] They used charts, drawn written or carried in the heads of pilots, could measure courses and distances, and the round-ships, merchants'-ships to employ the word in the Book of Proverbs, struck out over-seas for their port.

In his article on the Origin and Growth of Religion [5] Professor Sayce remarks, "There is now sufficient evidence to prove that at the very dawn of the historical period in Babylonia maritime intercourse was being carried on between this country on the one hand and the Sinaitic Peninsula and India on the other xx. As far back as 6000 years ago stone was conveyed by sea from the quarries of Sinai to Egypt and Babylonia xx. In the opposite direction we may infer that Chaldæan traders had also made their way to the western coast of India." [6] Of ships in the sea east of Arabia we have no details but they may be assumed like those of Egypt. Of the last we have representations on stones[7] and it would be satisfying to know from what country their sailors came. The Egyptian ships were manned principally by people of that country probably and no doubt the Chaldæans had sailors from Ur and near by, but there is reason to believe seamen in waters south and east of Asia and east of Africa were for many centuries Arabians. Colonel Yule who has bestowed much attention on the history of the East, in commenting on the similarity of tales recounted by travellers from different lands and in different periods in the Far East, observes that these are the yarns of Arab sailors, borne all over eastern

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4 Above pp 21, 5; also Book of Judges 5, 17; Psalms 107, 23–28.

5 Cited n 6 just above.

6 Breasted Ancient Times p 230, writes, "Egyptian ships common in the Mediterranean since the 30th century B C"; and p 252 gives cut showing ships proceeding in all directions across the Mediterranean.

7 Below pp 26 and foll'g.

seas and enduring for ages; "Handed down steadily," Yule writes,[8] "from the time of Ptolemy—peradventure of Herodotus—almost to our own day." Many of these are in the Arabian Nights, which dates from about 800 A D when Arab seamen and ships were in all parts of the world from the islands west of Europe and Africa to those east of China and Java and as far south as the Cape of Good Hope.[9] No nation has almost exclusively occupied so wide a region and never again may the like be seen. At the period Saracen princes and learned men in Cordova and Bagdad were building astronomical observatories, advancing the art of making instruments for use at sea, and calculating tables for finding position. In the Arabian Nights is the story of the love of Kamar al Zaman[1] son of the King of the Khalidan Islands and the Princess Budar, "Of the islands of the Inland Sea of the parts of China." The story covers wide geographical area for the Khalidan Islands are off the west coast of Africa, the Fortunate Islands they were also called. Arab ships were in China many years earlier than 800 A D and out in the Atlantic as well; the islands there were known in Spain more than 1000 years before the Saracens over-ran that country about 700 A D. It is generally believed the tales of the Arabian Nights were current in the East centuries before they were collected into the work we know and the story of the Princess Budar is perhaps very old for in it time is reckoned by weeks of 5 days and years of 72 weeks, a mode of measuring of remote antiquity.[2]

VERY OLD KNOWLEDGE OF CHINA IN SYRIA.

The Arabian Nights is called the Odyssey of Arab seamen and the voyages recounted are believed to have been as far as China.[3] There are other proofs that long voyages were many in early days: in the Book of Isaiah of date about 700 B C is written,[4] "Behold these shall come from afar; and lo these from the north and from the west and these from the land of Sinim." The land we call China has been called by several names among them Sinae, and it is believed the Prophet shows he knew where it

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8 Wonders of the East Hakl p XVII.

9 Below pp 233 and foll'g, 247.

1 P 212 v 3 Burton's trans; for comment see p 143 Westminster Review v 143 1895, History as Told in the Arabian Nights Hewitt.

2 Hewitt Hist and Chron Myth-Making Age p 55; Hewitt does not state the conclusion he draws.

3 Beazley Dawn Mod Geog v 1 pp 439–449 for abstract of 7 voyages of Sindbad the Sailor.

4 Ch 49, 12.

lay for he speaks of a distant land, Sinim, to the south and east; the way by sea from the Persian Gulf to China. This seems to be the conclusion of Colonel Yule.[5] Many believe Arab or Phenician seamen were in China very early. Lacouperie basing his statement in part on coins found says they were there about 675 B C,[6] and color is lent to this by the fact that Sennacherib King of Nineveh 700 B C brought Phenician shipbuilders, "The spoils of his bow" to Nineveh who built ships on the Tigris: the King had his people, "In great ships five days and nights as in a cage."[7]

To show Phenician and Arab seafaring and that of kindred peoples of their race was still widely extended at the beginning of the Christian era a passage in the writings of the Roman poet Virgil of 30 B C may be referred to.[8] Until the Portuguese reached the East ships of Semitic peoples belonging near the Red Sea were in all seas and islands west of Europe and Africa and eastward to the nearer edge of the ocean now called Pacific. A Roman admiral wrote about 100 years after the day of Virgil of the people of Arabia,[9] "One-half of these almost innumerable tribes live by the pursuits of commerce the other half by rapine, take them all in all they are the richest nation in the world xx for they sell the produce of the sea or their forests while they purchase nothing whatever in return."

THE CARRYING TRADE IN THE EAST IS WRESTED FROM THE ARABS.

Many of the men in the ships on the east and south shores of Asia and east of Africa, between harbors on the inhospitable coast of Siberia in the north and east and south and west to the Cape of Good Hope, were for long years Arabs. Chinese ships came to Java and the islands in the archipelago to its north-east, to Indian ports and the head of the Red Sea and Persian Gulf, ships of the Malays voyaged to the islands and China and India, and those of Japan came as far as Java: in all these vessels

5 Cathay and Way Thither 2 vs Hakl v 1 p XXXVI. See word *Sinim* in Smith's Dict Bible; where the view is that the Prophet knew of China and that his knowledge came by land; but in that case he would have described it situated to the north and east, the general direction from the Persian Gulf to China by land.

6 Western Origin Early Chinese Civilization p 95.

7 Hist Sennach trans from cuneiform inscript Smith p 90. The Phenicians have left trace in the Persian Gulf in buildings and names of islands; Heeren Hist Res Asia Eng trans v 1 pp 323, 434–39; v 2 p 385.

8 Given below pp 190–1.

9 Pliny Bohn in 6 vs v 2 p 90. Pliny's Nat Hist was published 77 A D 2 years before he was killed while in command of a Roman fleet by an eruption of Vesuvius.

Arab seamen were numerous while their own ships were probably manned exclusively by them.[2] When Da Gama reached a river on the south-east coast of Africa he called River of Good Signs or River of Mercy in latitude 20° S in the year 1498 this activity was about to be changed. At the River of Good Signs the Portuguese were supplied with pilots for India [3] and the new-comers were welcomed, but soon it was seen they would seize the trade: the Arabs were sad, so write Portuguese authors, but though resistance was made including fighting at the mouth of the Red Sea and Persian Gulf where the Portuguese desired to erect fortifications to stop ships which passed by those routes, the Arabs were over-borne. The coming of the Portuguese established through traffic between western Europe and the Far East and broke up that which had existed.

THE PICTURES OF SHIPS IN EGYPT.

The pictures on the stones of Egypt are the oldest yet found. In about 2900 B C Snefru King of Egypt built ships 170 feet long and during his reign 40 ships made a voyage to Phenicia for wood. This is the oldest over-seas expedition of which we have *written* record though others of older date are proved by trace of commerce and growth of geography. Nothing except what is just stated is known of the vessels of this expedition. A little earlier we have a tale belonging in about 3400 B C: a man goes to sea in a ship,[4] " 150 cubits long and 40 cubits wide with 150 of the best sailors of Egypt who had seen the heavens and the earth and whose hearts were more resolute than lions'. It had been forecasted that the wind would not become dangerous xx but the breeze freshened and raised waves 13 feet high." The ship foundered and our seaman whose tale is the oldest we have was cast away on a piece of wood on an island. Here he, " Passed 3 days alone without other companion but my own heart." The ship was on the high seas as a reading of the tale will convince any-one. Professor Petrie has written a work called Arts and Crafts of Ancient Egypt which shows and describes illustrations of very old vessels: one is

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[2] As to an early Board of Trade in India a voyage from India to China about 500 A D and traffic from China to the Persian Gulf, see below pp 206, 218, 236–7.

[3] See p 246 below for legend on a map of 1458 showing probable limit of Arab navigation south along east of Africa; below pp 245 and foll'g as to this meeting of ships of West and East.

[4] Flinders-Petrie Egypt Tales trans from Papyri pp 81–96; a cabin and an awning are mentioned and details of how the vessel was rowed and steered revealed.

on a vase and belongs in the,[5] " middle of the pre-historic age in the 2d civilization;" and the second, " rather later in the pre-historic age." The scale of the illustrations is small: the first vessel belonging as I read Prof Petrie's chronological table in 7000–6000 B C shows 2 cabins built on the deck to shelter those onboard and a number of oars in one horizontal row. The other vessel is of about the same date. These works of Professor Petrie give color to the history of the sea.

About 150 years later than the voyage of Snefru's reign, about 2750 B C, Sahure another pharoah records 2 expeditions; one to Phenicia and the other down the Red Sea to Punt; the Somali coast. Representations of the ships which went to Phenicia are on stones in a temple at Abusir [6] and it may be estimated they were about 100 feet long. The principal masts 25 feet long have 2 legs and are shown dropped towards the stern where they are carried on posts. There is a spar in inclined position; it is less in diameter than the legs of the principal mast and may be another mast; if it is the vessels had 2 masts one a little before the center of the ship's length and having 2 legs and the other near the stern: the illustrations are on small scale and this cannot be made out. There are 3 steering-oars on one side and presumably the same number on the other; each oar is about 12 feet long and the rowing-oars, in one horizontal line, are the same length as steering-oars and pass over the vessel's rail.[7] There are about 15 oars on each side [8] but this is not conclusive because only part of the vessel's length appears. This is the oldest representation of sea-going ships for the vessels mentioned by Petrie and Mosso described above are river-craft. Two pictures are in Borchardt's paper; one marked, " Sea-ships returned from Asia " and the other, "Sea-ships "; but whether these words are on the stones does not appear. The ships are returned to the Nile-mouth from Phenicia, 400 miles straight across and 500 if the coast is followed. The vessels sent to Punt by Sahure are nowhere represented; neither was his the first expedi-

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5 P 55. The date of the ships is fixed by Chron table p VIII. For other very old Egyp ships see illustr p 269 Mosso Dawn Medit Civilization; these are carved on natural rocks and of neo-lithic period.

6 Photos will be found Mitt der Deutschen Orient-Gesell zu Berlin Aug 1908 no 37 Borchardt.

7 The dimensions are estimated by the height of the men; an unreliable way but the only one available.

8 As oars cannot be placed nearer than 2–1/2 feet from one another 15 oars go to show a vessel 70 or 80 feet long.

tion to that place, for Assa an Egyptian King sent one earlier.[9] Very lately small models of Egyptian craft of 2000 B C were discovered in the tomb of a great personage with other interesting objects. These are in the Metropolitan Museum in New York and the circumstances connected with the finding are in Scribners' Magazine for February, 1921. Some are propelled by oars and some by paddles and one appears to have had a sail. The rowing-oars are spoon-oars while steering-oars placed at the quarter have flat-blades.[1]

QUEEN HATSHEPSUT'S SHIPS.

Queen Hatshepsut sent ships to Punt about 1500 B C and pictured the ships on monuments. They descended the Nile from Thebes and probably passed by canal into the Red Sea; the evidence for the existence of a canal being only that in the illustrations of the stages of the voyage there is no trans-shipment from one ship to another. The ships are shown in Breasted's History of Egypt p 275 and the history of the carvings given. Pictures will be found also p 179 Rawlinson's Egypt and larger ones in Duemichen's Flotte einer Ægyptischen Koenigen. There is a model taken full-size from the stones in the Metropolitan Museum in New York. This is the most interesting reproduction of all but the plates in Duemichen being large though not full size show the ships well. They have one mast only, a single spar, and on this one sail, there being a yard at the foot as well as head. When the ships are loading the upper yard is lowered and the sail furled on it; as this is a heavy spar—perhaps 50 feet long—the ships had pulleys with revolving sheaves. The two yards show they could lie close to the wind; perhaps not as close as modern square-riggers; 6 points but about 7. The sails could drive the ship at good speed; when it blew hard they made as good speed as modern vessels. The vessels have usually—a number are shown in Duemichen's book—15 oars on a side, each pulled by one man and in one horizontal row; they pass over the rail through grummets as oars are now rigged. This oarage as the ships have long over-hangs at bow and stern shows the over-all length was not less than 80 feet and beam 10 feet. In most vessels below the oars in their wall-side appears one horizontal line of small rectangular figures; these may be air-ports as we would say and if they are show the

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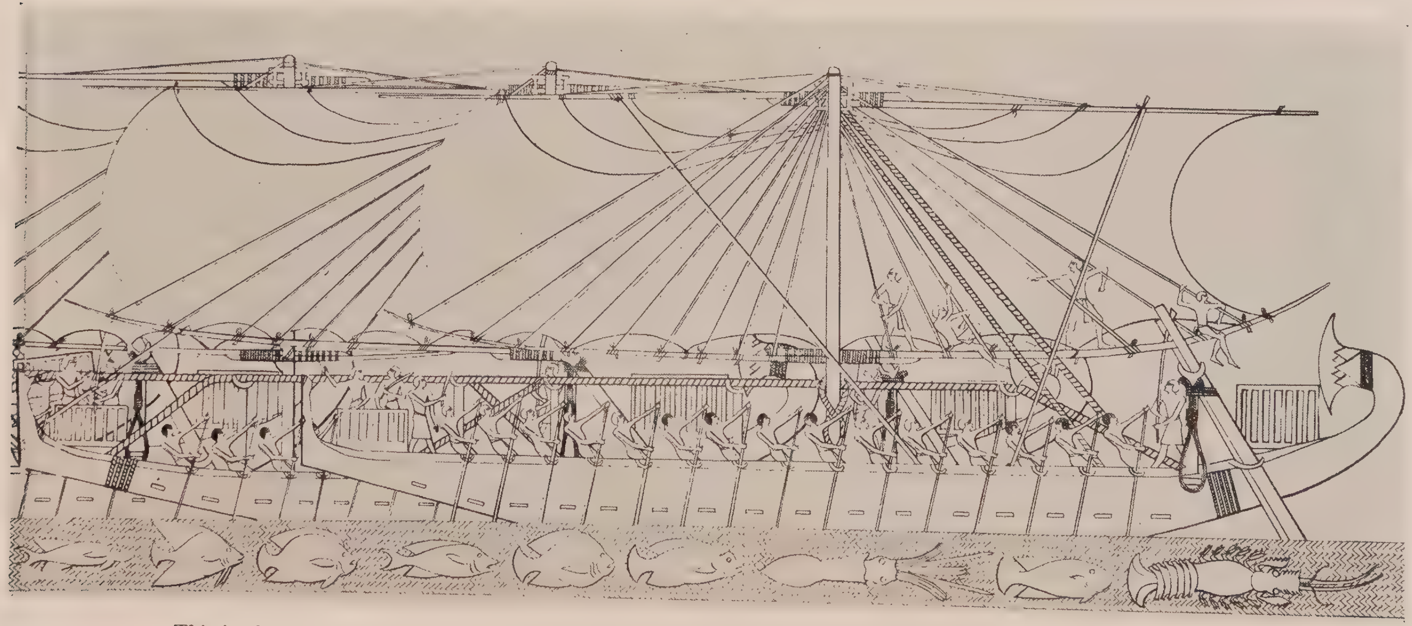
[9] Kennedy Early Com Baby with India Jour Roy As Soc new ser v 30, 1898 p 244.

[1] See below p 207 n 7 for spoon-oars in the Far East at same date.



This is pl. 1 Duemichen's Flotte: it is from the Egyptian carvings showing Queen Hatshepsut's ships; 1500 B. C.

vessels were decked from end to end: or they may have been used to thrust oars through.[2]

This line of figures is of interest in respect to rowing. In other plates of Egyptian ships 3 such lines are shown;[3] if they are to thrust oars through the vessel was of the rating called by Greeks *tetrere*, by Romans *quadrireme;* that is *four-oar*. The vertical side of the vessel with 3 lines is 8 feet, so that if equally spaced from each other and from the water-line and upper rail of the vessel, and oars used at the level of the rail and each row of holes, there would be 4 lines of oars with 2 feet between each pair of lines. This is enough height to put in an oarsman. There are ancient records hard to put aside of oars used at more than one level; the oldest being a picture of a Phenician *diere*, *bireme*, *two-oar*, of date 700 B C. In modern day we find similar arrangements; Fournier a French author of 1650 says of fighting-ships called two-deckers and three-deckers, that is vessels carrying guns on 2 or 3 decks,[4] "Vessels having several decks pass an oar out at each port and putting 5 men on each oar of 35 feet take such advantage as possible of the enemy." What would Herodotus or Greek or Roman writers call a French three-decked ship of 1650, of date of Tourville Ruiter and Blake, with oars arranged thus. Admiral Serre who has given much attention to ancient ships thinks oars were used at different heights according to the service performed;[5] but how they were used may probably never be determined.[6]

SOME DETAILS REGARDING EGYPTIAN PICTURES.

The Egyptian ships depicted on stones are round-ships, freighters; in the Field Columbian Museum in Chicago is an actual vessel of another class. She is 30 feet long 8 feet wide and 4 deep, built of cedar of Lebanon —of wood from Phenicia. If moored to a wharf in Lake Michigan she would attract little attention so like is she to modern craft. She was found in a tomb in Egypt and is identified as belonging in the reign of Sesostris III, 1800 B C. An illustration will be found p 170 Breasted's

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2 Wilkinson Man and Cust Anc Egyptians v 3 p 201 calls these *false windows*, by which term he means presumably air-ports; see same v pp 184–214, Egypt Boat Builders. See picture at p 50.

3 The 29th Mem Egypt Expl Fund pl 154; see also pl 153. In the text the vessels are said to have been 210 ft long and 69 beam.

4 Hydrographie, 1667 p 28: below pp 33 regarding Phenician two-oar and 74 and foll'g as to arrangement of oars in general.

5 Marines de Guerre de l'Antiq et Moy Age Serre; 2 vs v 1 p 23 and Resume p 101.

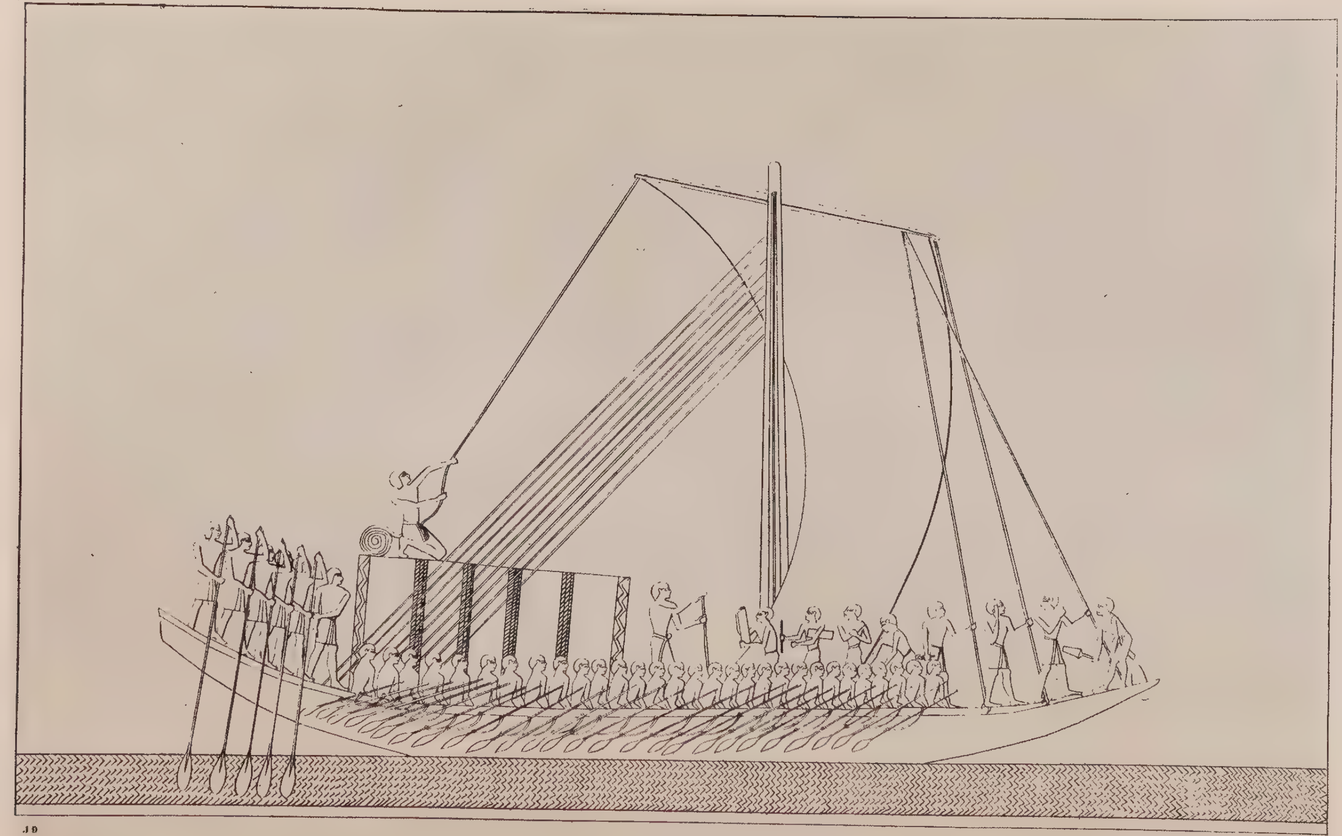
6 Below p 83 n 2 as to where ancient vessels might be recovered.

History of Egypt as well as her story. Duemichen's plates show 2 important features not yet alluded to: (1) plate 26 shows a vessel of 3000 B C on a pyramid at Saqara in Egypt having 26 oars on one side, each pulled by one man and in one horizontal line; such an oar-space would be quite 70 feet long and the vessel more than 100 feet long. The oars are along the rail in inclined position with blades clear of the water and the vessel is under sail alone; one deep sail on a single—one-legged—mast with yard at the head only of the sail. There is another interesting point; oars pass over the rail through a grummet as was common and on each grummet is shown a loose loop of rope which may be a lanyard to trail the oar by. As will be shown below trail-lines seem indispensable in ram-vessels; but there is no other indication of the way oars were cared for when ships passed one another.[7] (2) There is a feature by which the draft of water of a vessel is indicated: in plate 2 one is shown with side near shore and men carrying loads up inclined boards one end of which is on the vessel's rail and the other on the bottom in 5 feet of water, for the men are to the neck when they step on the boards. With these data the draft cannot be exactly determined but it was as much as 10 feet.

THE NILE-RED SEA CANAL.

Reference has been made to a canal between the Nile and Red Sea.[8] Herodotus says,[9] "Necos was the first to attempt the construction of a canal to the Red Sea a work completed afterwards by Darius the Persian; the length of which is 4 days' journey and the width such as to admit of 2 trieres being rowed along it abreast." The length from out to out over the ends of the oars of a triere was about 50 feet so the canal must have been over 100 feet wide. Herodotus goes on in the same place as regards the route of the canal and concludes by saying Necos, "At length desisted from his undertaking in consequence of an oracle which warned him, 'He was working for the barbarian.'" That Darius finished the canal as Herodotus states is proved by this inscription made by him discovered along its route,[1] "I commanded to dig this canal from the stream flowing in Egypt called the Nile to the sea which stretches from Persia. Then the canal was dug as I commanded and ships sailed from Egypt through the

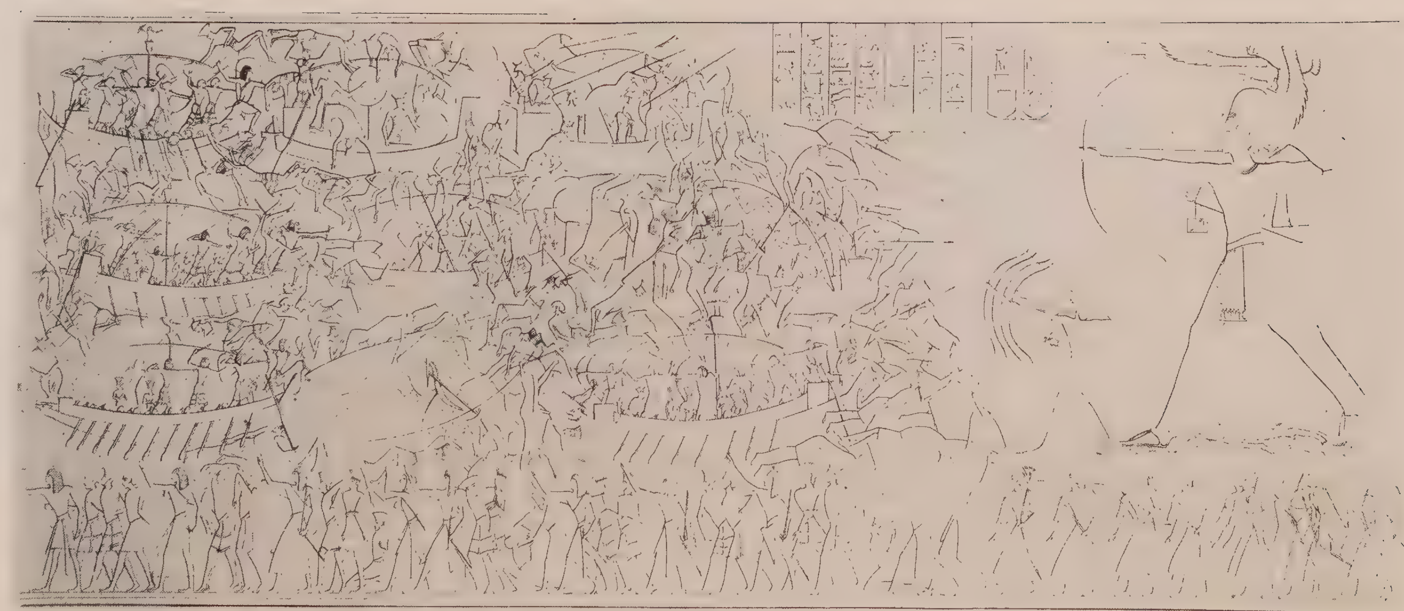
[7] Below p 116: see picture here inserted.
[8] P 5.
[9] Rawlinson's Herod v 2 note p 242: Necos was King 609–593 B C.
[1] Breasted Anc Times p 187; p 36 is shown the route of the canal.



Aus einem Pyramidengrabe von Saqara.

der V. Dynastie angehörig. III. Jahrtausend v. Chr.

An Egyptian ship of about 3000 B C: it is pl 26 Duemichen's Flotte. The oars are held to the tholes by grummets and fitted with loose lines that must be for trailing. The mast has back-stays and the yard braces and halliards; the last pass over a sheave in the mast; it must be a live and turning sheave, otherwise so heavy a yard and sail could not be hoisted



Oldest picture of a battle at sea: it is pl 131 Rosellini's work identified n 5 p 31: see same p for description: the date is 1200 B C.

canal to Persia according to my will." We have record of a ship in the canal as late as 825 A D.[2] As to its history in general see Finlay's Historical Account of the Nile Canal[3] Rennel's Geographical System of Herodotus and Heyd's Commerce du Levant.[4] The last author states when the ocean route to the East was discovered the Venetian Senate in 1504 drew up a resolution in regard to piercing the Isthmus of Suez but abandoned the attempt for fear of angering the Turks and that in 1529 the Turks had 20000 men working on the canal; they never finished it however.

THE OLDEST PICTURE OF A BATTLE.

Carved on stones at Medinet Habu is the oldest picture of a sea-battle. It occurred off the mouth of the Nile 1200 B C. There is written description of the battle showing the contestants were Egyptians and "northern races" that ships were capsized and that bows and arrows and slings were used.[5] Nine ships are fighting, 4 having fighting features more developed than the others. All 9 have raised decks at bow and stern the thing added in all parts of the earth to make ships fit to fight. The 4 having developed fighting features show bow-and-arrow men on their decks slingers in protected crows'-nests at the mast-head and at the bow above water a blunt ram. They have 10 or 12 oars on a side the oarsmen are *protected against missiles by a raised bulwark* and oars are in one horizontal line. The ships of the "northern races" have no oars no archers no slingers no protecting bulwark and no ram. The ships have one mast, on this one sail and sails are brailed up to the yard left at the mast-head. There is no yard at the foot of the sail. All we know of this is from the carvings at Medinet Habu; how the ships formed for fight and advanced to attack is not recorded. As usual in all days the ships had names, as Battle-Animal and Glorious-in-Memphis; the officer in command was called Chief-of-the-Ships.[6] All arrangements for war in the day were well regulated; in 1288 B C Egypt sent an army of 30000 over-

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[2] Above p 5.

[3] Blackwood's Edinb Mag August 1844.

[4] French trans v 2 p 552: Rennel wrote 1830 Heyd 1879.

[5] The inscriptions are in Breasted's Anc Rec Egypt v 4 pars 75–7. Reproductions of the illustrations are in Rosellini's Monumenti dell' Agitto e della Nubia v 1 pl 131; Breasted's Egypt p 480; Rawlinson's Egypt p 278; and comment on the battle in Jal's Arch Nav v 1 pp 50–54: see picture inserted.

[6] Erman's Anc Egypt Eng trans p 542.

seas to the coast of Syria near Kadesh and maintained it there: the length of the sea part of the line of communication is 500 miles.[7]

THE GREEKS AND ROMANS COME TO EUROPE: THE PHENICIANS.

The Greeks and Romans came into the peninsulas they were to live in in 2000–1500 B C and the history of their languages shows they had not yet seen a merchant-ship, a great sailing-craft,[8] though some may have stood in a river-boat and spread some object to catch the wind. As on some rivers there are steady winds it is impossible this had not been done; but the ocean and a ship with the trunk of a tree set up in her and a sheet of cloth or skins hung on a cross-yard borne aloft by the spar, no Greek or Roman had looked upon. The Greeks were to make these their own and improve them and Romans to do something for them.[9] It is generally believed Rome left little impress on the history of ships; she was however a commercial city from early date,[1] made commercial treaties with Carthage in 509 and 348 B C whose terms have been preserved,[2] maintained a permanent war-fleet against pirates in the strait between Sicily and Italy in 482 B C, and her ships were trading in competition with Phenicians as far away as in the Atlantic Ocean in 350 B C.[3] Rome was to acquire dominion of the sea throughout the western world; this she did by fighting and destroying ships and commercial emporia, keeping only those deemed necessary to secure her power and riches. At about the time the Greeks and Romans reached the sea in their new lands, 1500 B C, Egyptian shipping in great part disappears and we hear little of it for 1000 years: not until the reign of the Ptolemys who succeeded to the throne of Egypt about 325 B C upon death of Alexander the Great do we hear much of Egyptian ships but then they are the largest and most famous in the world. The later Egyptians drew no pictures of ships and what we know of those of the later day is from written descriptions. There is a

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[7] Breasted Battle Kadesh Decennial Pubs Univ Chicago 1904.

[8] Above pp 9–10.

[9] The fore-and-aft sails called *lateen*, that is *latin*, were employed before the day of the Latins.

[1] Mommsen Eng trans in 5 vs v 2 p 39.

[2] Below pp 70–1. Rome began to war on Carthage 264 B C; thus the cities traded peacefully for at least 250 years: the wars went on till 146 B C, 120 years; in 146 B C Rome having destroyed the power of Carthage burned the city after taking over all ships and military stores. In the same year she razed and burned an equally famed commercial city, Corinth. Julius Cæsar planned the rebuilding of both but they never attained importance.

[3] Mommsen cited 2d note above v 1 p 331 and v 2 p 45 for last 2 statements.

multitude of allusions to ships in the ancient authors, most of whom had been at sea and all had seen ships, yet it has not been determined how the oarsmen sat. Following strictly the texts we can imagine and sketch a triere, trireme, three-oar, but not a 20-oar, 30-oar, 40-oar; all of which we find named. Three men can sit one above the other or all on one thwart, and in either of these ways or in the way of 3 men all on one oar the name may have arisen; but none of these plans is possible in the case of the larger numbers. We have little help from ancient authors regarding this; yet in reading the operations of ancient ships there is nothing that may not be satisfactorily understood.[4]

PICTURES OF SHIPS WITH OARS AT SEVERAL LEVELS AND FITTED WITH RAMS.

There are pictures of Phenician ships in the service of Assyria drawn in 700 B C showing oars in 2 horizontal lines,[5] one of a 3-oar on the Acropolis at Athens of date 400 B C[6] and vessels showing oars in both 2 and 3 horizontal lines are on Trajan's Column in Rome.[7] The date of this is 100 A D. The vessels on the Assyrian carvings with rams are war-vessels as are those on the Acropolis and Trajan's Column. The ships sent out by Sahure and Hatshepsut show no spurs while some shown in fight off the Nile-mouth in 1200 B C have them. In the Assyrian carving 10 biremes are shown, 5 with sharp under-water rams and 5 without rams. The vessels on Trajan's Column all have rams. Thus in the earliest battle on the sea of which we hear rams were employed. These call for speed and handiness and the only way to gain speed is to employ more rowers: as length diminishes handiness they must be seated closely either abreast or one above the other. We return to this below, remarking that oarsmen were packed very close and that fighting row-ships existed certainly before 1500 B C and later than 1500 A D: it is indicated they were used much earlier than 1500 B C for the term war-ship occurs in Egyptian inscriptions of 2500 B C.[8]

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4 The placing of oarsmen is returned to pp 72 and foll'g.

5 Plates Ass Sculptures Palace Sinacherib The Hague 1912 Paterson; Layard Mon of Nineveh: see Layard's Nineveh and Rawlinson's Phenicia for small cuts of these. Sinacherib's date (so the editor spells the name) is 705–681 B C. See pictures here.

6 Cartault's Triere Athenienne; v 1 Serre's Mar de Guerre. It is a misnomer to call a Greek three-oar a trireme; the Greeks used their own language and called these trieres, the Romans used theirs and called them triremes: the same is true of all rates.

7 Col Trajani Ortographia Rome 1773 Salomonius; pl 29 and others show biremes and pl 72 fig 236 a trireme. These are shown also p 418 v 2 Serre.

8 Anc Rec Egypt Breasted v 1 pp 148–9.

PHENICIAN SEAFARING.

The name Phenicia was applied to a narrow strip north of what we call the Holy Land extending north and south in the eastern shore of the Mediterranean; the sea was west of it and the Lebanon mountains east. On the slopes of these grew the timber the Egyptians sent ships to fetch in 2900 B C [9] their land being without timber, and which King Solomon used in building the Temple and ships at the head of the Red Sea to go to Ophir.[1] Phenicia's seaports were Sidon first and Tyre at later date.[2] Kenrick an Englishman writes,[3] " Tyre xx flourished as a commercial city during at least 25 centuries; it fell because it was not strong enough to protect its riches against aggressors and rose again after temporary depression with an elasticity which has no parallel. The spring of that elasticity was its commerce. It might have revived and flourished even under Turkish sway had not the trade of the world found new channels for itself since the discovery of the Cape of Good Hope and America leaving dry many of its ancient seats along the shores of the Mediterranean." The Phenicians left no written history. Heeren says of them,[4] " The Phenicians carried the nautical art to the highest point of perfection at that time required or of which it was then capable and gave a much wider scope to their discoveries and enterprises than either the Venetians or Genoese in the Middle Ages. Their numerous fleets were scattered over the Indian and Atlantic Oceans and the Tyrian pennant floated at the same time on the coasts of Britain and shores of Ceylon." Mommsen writes,[5] " The field of their commerce reached from Sierra Leone and Cornwall in the west eastward to the coast of Malabar."

Phenician ships were to be found about 1000 B C from Britain to Sierra Leone in the Atlantic, latitude 50° N to the equator, and eastward to India and Ceylon; and we are not without indication of earlier Phenician seafaring, for Snefru sent ships from Egypt to Phenicia for

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[9] Above p 26.

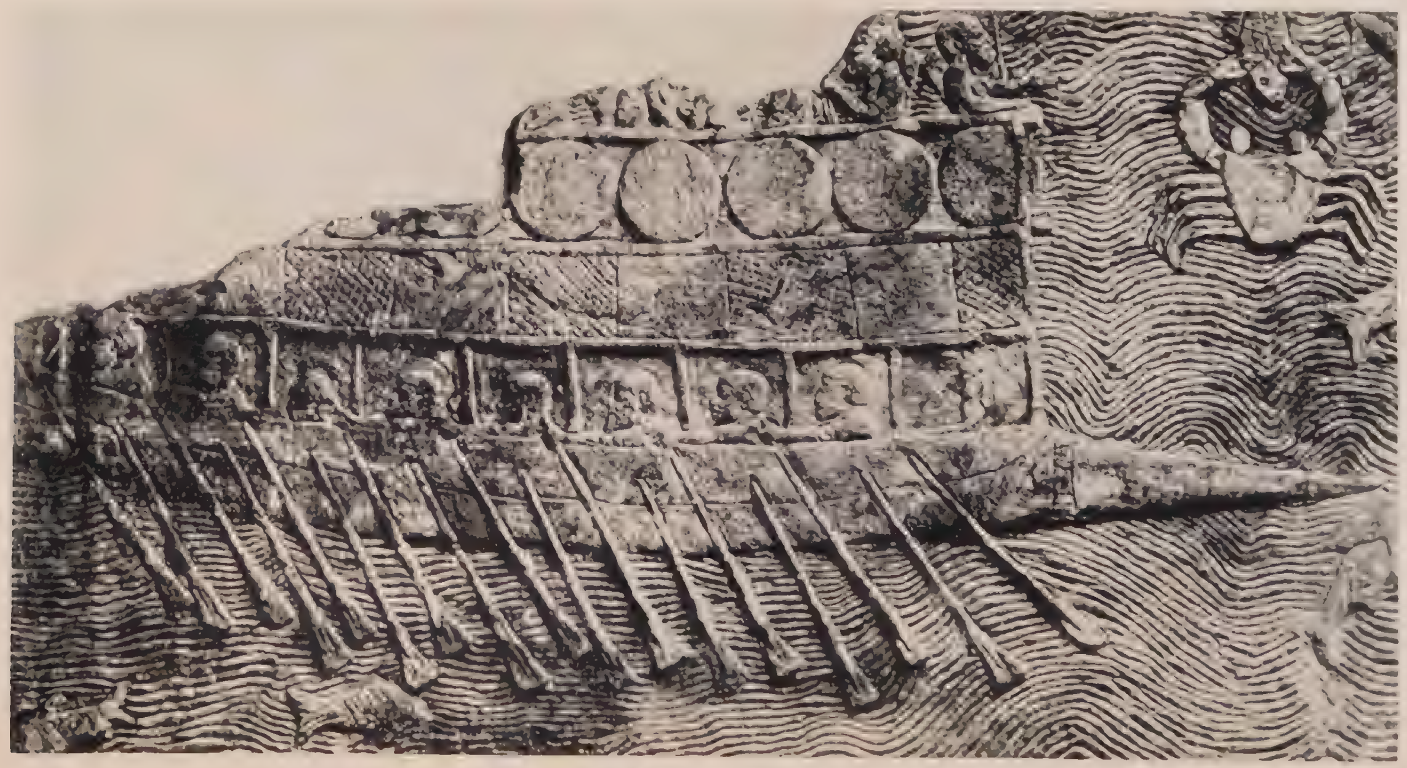
[1] Below p 70 for written treaty between Solomon and Hiram.

[2] The words Sidon and Nineveh both mean fish-town; the cities were founded about 2500 B C; see Ruling Races Pre-Hist Times Hewitt p 286. The word Sidon occurs Genesis 10, 15; see McClintock and Strong's Bib Dict word Zidon. Ur and Sidon are the oldest sea-ports of which we have account.

[3] Phenicia p 455: written 1855.

[4] Hist Res Asia Eng trans v 1 p 340.

[5] Rome Dickson's trans v 2 p 3.



From photo of moulding in British Museum given in Paterson's work mentioned n 5 p 33: she is a bireme of date 700 B C: on her highest deck are men; then come circular objects ranged along which must be shields; I do not know what the squares filling the next space are, but since the picture of Phenician ships next p has these only in vessels having spurs it is peculiar to war-ships.

This is pl 71 Layard's Mon of Nineveh, where labelled, "The enemies of the Assyrians taking refuge in ships;" it is drawn from a carving and its date is 700 B C : 5 are war-ships and 5 are not. There are several pictures of ships having *oars* in more than 1 level, being made in different places and dates, but in none except the modern Eastern 3-oar referred to p 85 below are more than the upper line of *oarsmen* to be seen.

ship-timber in 2900 B C and Sidon was a port at about that time.[6] Corroboration comes from the fact that tin amber ivory spices of many kinds live animals and cotton and silk fabrics were carried great distances; these were common in lands far from those in which they originated before Snefru sent ships to Phenicia. Every warrior used arms made in part of tin and every woman had similar utensils in her house. In about 1000 B C Solomon built a fleet at the head of the Red Sea and the Jews not being seafarers turned to his neighbor Hiram of Tyre for assistance. We read regarding this in the Bible,[7] " Now Hiram King of Tyre had furnished Solomon with cedar trees and fir trees xx. And King Solomon made a navy of ships at Ezion-geber which is beside Eloth on the shore of the Red Sea in the land of Edom. And Hiram sent in the navy his servants shipmen that had knowledge of the sea with the servants of Solomon. And they came to Ophir and fetched from thence gold xx. And all King Solomon's drinking vessels were of gold xx for the King had at sea a navy of Tharshish with the navy of Hiram; once in every 3 years came the navy of Tharshish bringing gold and silver ivory and apes and peacocks."

Ezion-geber is at the head of the eastern of the 2 forks into which the Red Sea divides at its northern end and thus nearer than the Nile to the territory of Hiram and Solomon. From here down the Red Sea and across to India is 3000 miles and we may well believe it took 3 years to make the voyage out and home due to the fact that time would be spent in India for disposing of the out-cargo re-loading and rest: the ships may probably have remained in India over a monsoon. These winds, blowing from north-east for 6 months and from south-west for the remaining 6 months of the year, were known to the peoples dwelling in these parts before the day of Solomon. Before astronomical knowledge had progressed enough to enable more accurate means by the motion of the moon and sun to be developed the monsoons were used to measure the passage of time and the seasons.[8] As regards whether the shipmen of Hiram went to India in one ship without transferring their cargo to other vessels it may be stated it was usual for ships to go comparatively short distances and cargoes and sailors to change when the run was long; on the other hand, as the Phenicians were nearly akin to the Arabians, of which nation seamen in eastern seas were, there was probably no animosity

[6] Above p 5.
[7] First Kings chs 9 and 10.
[8] Hewitt Prim Traditional Hist p 4.

between the two. The articles brought home, certain spices and peacocks, point to India as the place from which the cargoes came whether one ship went all the way or not.[1] The First Book of Kings is the best evidence Phenician ships went to India; but there is evidence in that from very early days spices were brought from the east and these must have come by sea. In the Book of Exodus, ch 30, 23 and following verses, will be found directions for mixing a large weight of ointment composed of ingredients some of which grow only in India and east of it.[2] It may be noted that the Jewish historian Josephus who lived about 100 A D and may have been in possession of evidence now lost wrote,[3] " Solomon gave to the pilots furnished him by Hiram of Tyre commands that they should go along with his stewards to the land that of old was called Ophir but now Aurea Chersonesus which belongs to India to fetch gold." If we take this literally Josephus means the ships went to the Peninsula of Malacca; called by Ptolemy the Geographer who was of Josephus' day Aurea Chersonesus. It is clear that Josephus who dwelt in Syria and must have known seamen and travellers there saw no difficulty in ships going from the head of the Red Sea to Malacca.

Silk also came from the Far East in ancient days. The Histoire de la Soie Pariset tells us Ptolemy the Geographer of about 125 A D knew the extreme east, the land we call China, by 2 names; he called the east coast of Asia to the north Serica and connected this with the material silk; the land further south he called Sinae. Pariset writes,[4] " The origin of the word Sinae is the Arab word Sin; for the Arab navigators Sin was the country of Thsin, China. Ptolemy had then a double notion of the country one coming by land xx the other by sea." We have 2 other mentions of China in Ptolemy's date; one by the author of the Periplus of the Erythræan Sea, a Sailing Directions we would say of the south and east coasts of Asia, and the other in the Itinerary of Pausanias.[5] By Pausanias

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[1] Vincent Com and Nav of Anc in Ind Ocean v 2 p 619: see also this v pp 460, 577 as to details respecting long carriage of commodities.

[2] Also Psalms 45, 8; Ezekiel ch 27 and 28: also the story in Plutarch's Life of Alexander the Great Langhorne ed v 4 p 162 of how Alexander, having once been reproved by a tutor for throwing incense by hand-fulls into the fire, sent him a great quantity of it while on his march through Asia so that he, " Might no longer be a churl to the gods." As to free use of incense in early day see also below p 194.

[3] Works Flavius Josephus Havercamp's ed xx by Whiston Antiq of Jews v 1 p 428.

[4] V 1 p 108. See also below pp 208–9.

[5] Perip Eryth Sea trans Schoff: Itinerary Pausanias Frazer trans v 1 p 324. Extr from these are on pp clvii and cxliv v 1 Yule's Cathay 2 vs Hakl. See below p 207 as to Perip Eryth Sea.

whose date is 150 A D came to Europe the first correct description of how silk is produced and from the context it is clear the description came by sea. At earlier periods it was believed it grew on trees.

Such are the reasons for believing ships trafficked with the East before 1000 B C. We come now to proof they went to Britain and Sierra Leone in the Atlantic: the Phenicians founded Gadir now Cadiz outside the Strait of Gibraltar about 1150 B C, and Carthage to become one of the great powers of the earth in 850 B C. Bunbury writes in his Ancient Geography,[6] "It is certain that the principal if not the sole source from which the tin used by the nations of the Mediterranean was supplied was certain islands in the Atlantic known to the Greeks as Cassiterides or Tin Islands." Our perplexity in regard to tin will not be diminished by the fact that bronze, copper with admixture of tin, was used in Egypt in 4800 B C and widely employed there by 2000 B C;[7] thus ships were carrying tin between ports of Europe before the day of King Solomon. Herodotus wrote about 450 B C,[8] "Tin and amber do certainly come to us from the ends of the earth." There is evidence also in the Bible that Phenician ships were the carriers of tin and other metals: in Ezekiel we read,[9] "Tarshish was thy merchant xx. With silver iron tin and lead they traded in thy fairs."

The proof that Phenician seamen went south in the Atlantic is a voyage of exploration made by them in that direction in 450 B C under Hanno. The record of this is the oldest traverse to use a term common among seamen in existence. Hanno's inscription runs,[1] "It was decreed by the Carthaginians that Hanno should undertake a voyage beyond the Pillars of Hercules and found Liby-Phenician cities. He sailed accordingly with 60 penteconters and a body of men and women to the number of

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[6] V 1 p 10. The dates given for founding Cadiz and Carthage are from Kenrick's Phenicia. The Cassiterides or Tin Islands are believed to have been at the S W end of England.

[7] McCabe Story of Evolution p 315.

[8] Bk 3, 115. Nansen North Mists Eng trans v 1 pp 28–31 gives cut showing where tin mines are found and its routes in anc days; p 14 same v it is stated amber has been found in Greece in ruins of 12th to 14th century B C shown by chemical analysis to have come from the Baltic.

[9] Chap 27. The Prophet's date is 600 B C. This chapter with the writings of Homer 400 years earlier constitutes the oldest description of the furnishing of ships.

[1] Heeren Hist Res Africa v 1 p 486 Eng trans for the inscr complete; its history is given p 92 same v. See also Voy Hanno trans Falconer; Rennel Geog Herodotus v 2 p 431 has traced the track of Hanno's fleet as far as 7° N. Bougainville has a French trans in Mem de l'Acad des Inscriptions tome 6 p 40.

30000[2] and provisions and other necessaries. When we had passed the Pillars on our voyage and had sailed beyond them 2 days we founded the first city xx. Proceeding thence toward the west we came to Soloeis a promontory of Libya xx, and again proceeded for the space of half-a-day towards the east until we arrived at a lake lying not far from the sea xx. Thence we came to the great river Lixus xx. Having procured interpreters [3] here we coasted along a desert country toward the south 2 days. Thence we proceeded towards the east the course of a day. Here we found in a recess of a certain bay a small island xx and called it Cerne. We judged from our voyage that this place lay in a direct line with Carthage for the length of our voyage from Carthage to the Pillars was equal to that from the Pillars to Cerne xx. Then we sailed towards the south 12 days coasting the shore xx." Traffic of the Carthaginians in these parts existed before else Hanno would not have been sent to found cities. What sailors call traverses include courses and distances; Hanno gives courses by the trend of the land and divisions of the horizon circle and distances in days'-runs. Herodotus tells the length of a day's-run; "In a long day," he says,[4] "a vessel generally accomplishes about 70000 fathoms; in a night, 60000:" that is a day's-run is 130 miles, 5½ miles per hour.

At about the date Hanno went south the Carthaginians sent Himilco north in the Atlantic. The record of this expedition is so poor that no more can be said than that the ships probably went to Britain.[5] There is other proof of these voyages in the fact the islands in the Atlantic lying off Africa were known from early times. Aristotle 350 B C tells us,[6] "In the sea outside the Pillars of Hercules they say an island was discovered by the Carthaginians xx distant several days' journey from them xx." These islands, the Azores or Madeira, they cannot have been the Canary Islands which are visible from the continent, were on maps made after this day. In 82 B C the Roman general Sertorius being in Spain encountered

[2] There must be mistake here: these vessels had 50 oars 25 on each side; they were not more than 100 feet long and could not carry 500 persons. Ancient records are particularly liable to errors in numbers because of methods of notation used.

[3] This must mean pilots proving there was already seafaring there.

[4] Bk 4, 86. See p 47 n 4 below regarding Herodotus' word for fathoms.

[5] Himilco's voyage is preserved by Avienus who lived 800 years after; see Heeren Hist Res Africa v 1 p 496 Eng trans. There is a French trans of Avienus by Despors et Saviot 1843.

[6] Eng trans Smith and Ross v 4, Mirabilibus Auscultationibus p 836 b 84: see p 844, 35–36 for tale that so great was the quantity of silver in Spain the Phenicians after loading their ships with it made all utensils including the anchors of silver and left their former utensils behind.

seamen,[7] "Newly arrived from the isles of the ocean;" and deeming it not improbable the fortune of war might be against him considered retiring with his friends to the islands, to live in peace. That the seamen could convey him thither shows they had maps extending west on which the islands were depicted or perhaps only carried such knowledge in their heads. In the later day of the Mahometans these islands were also familiar.[8] Circumnavigation of Africa by Phenicians in the service of Egypt about 600 B C and the voyage of Scylax along the coast of Asia 100 years later both alluded to again just below add to the credibility of the voyages of Hanno and Himilco. A century later, about 350 B C that is, is found further corroboration in the Voyage of Nearchus,[9] This is more like the log of a modern ship than the records of Hanno and Himilco and has been subjected to exhaustive examination by Vincent,[1] who takes from the record the runs of the ships for each day. It would require so much space to insert an abstract of the voyage that no more can be done than refer to the place where this may be found.

Establishment of trade to India and in the Atlantic before others had gone so far was the great achievement of the Phenicians. At later date they made a voyage around Africa: Herodotus says,[2] "As for Libya we know it to be washed on all sides by the sea except where it is attached to Asia. This discovery was first made by Necos the Egyptian King who xx sent to sea a number of ships manned by Phenicians with orders to make for the Pillars of Hercules and return to Egypt through them and by the Mediterranean xx. It was not until the 3rd year that they doubled the Pillars of Hercules and made good their return home xx. Next to these Phenicians the Carthaginians according to their own accounts made the voyage xx. Of the greater parts of Asia Darius was the discoverer xx. He sent a number of men xx among them Scylax of Caryanda to sail down the Indus. They xx sailed down the river to the sea. Here they turned westward and after a voyage of 30 months reached the place from which the Egyptian King of whom I spoke above sent the Phenicians to sail around Libya. After this voyage Darius conquered the Indians and made use of

[7] Sertorius Plutarch's Lives. Madeira is 650 and the Azores 1000 miles from the continent.

[8] Above p 24.

[9] Voyage Nearchus chap 27 p 255 and foll'g Arrian's Hist Alexander's Exp trans Rooke.

[1] Com and Nav Anc in Indian Ocean.

[2] Bk 4, 42–5; Necos was King 609–593 B C.

the sea in those parts."[3] By 600 B C ships had explored west from the Indus to the Persian Gulf thence south along Arabia to the Red Sea and from there had rounded the south of Africa and returned to Egypt by the Strait of Gibraltar and the Mediterranean. Some 250 years later as we have just seen Nearchus also made the voyage from the Indus to the Gulf of Persia.

Herodotus writes,[5] "India xx is the farthest region of the inhabited earth towards the east;" after describing the limits west north and south he goes on, "Tin and amber do certainly come to us from the ends of the earth." After Herodotus we hear of seafaring in the East from the Periplus of the Erythræan Sea, whose author, his name is unknown, was a seaman or merchant, terms in the day nearly synonymous. This work was written about 80 A D and says of Chryse as the Peninsula of Malacca is called and of China,[6] "Behind this country [that is behind or beyond Chryse, the Malacca Peninsula] the sea comes to a termination somewhere in Thin and in the interior of that country quite to the north there is a very great city called Thinae from which raw silk and silk thread and silk stuffs are brought." The writer gives no details regarding ships and sailors though he went in ships to the places he described. As Alexandria and the region near-by was part of the Roman Empire the ships and sailors may have been Greek or Roman; but as the Arabs had long frequented Far Eastern seas while Greeks and Romans had done this occasionally only it seems likely ships and seamen were of Arab origin.

MARINUS OF TYRE.

Marinus of Tyre lived just before Ptolemy or about 100 A D and from him Ptolemy took large part of his Geography. The Phenicians must therefore have had many ships as late as 200 or 300 A D and Marinus was the repository of the knowledge of Phenician seamen. He received and collated the logs of Phenician ships voyaging from the Atlantic Islands in the west to China in the east and made maps from these. Ptolemy tells us this [7] and if Ptolemy had not stated he used maps

[3] Darius was King of Persia 521–486 B C; Herodotus means the Persians found on this coast a paying traffic which Darius appropriated.

[5] Bk 3, 106; above p 37.

[6] Yule's Cathay 2 vs Hakl v 1 p cxliv; Schoff Perip Erythr Sea p 48; McCrindle Perip Eryth Sea Calcutta 1879 p 147; Vincent Com and Nav Anc Ind Ocean.

[7] See Heeren Politics Asiatic Nations v 2 app 12 pp 440–50, On the Sources of Ptolemy's Geography.

Marinus made and data he supplied we should not have known such a person existed and an important link in the history of seafaring would have been lost, for we should not have known so much of Phenician seafaring. The Phenicians were still in 200 A D *wagoners of the sea* as the Hollanders styled themselves more than a thousand years later.

The so-called Map of the World According to Ptolemy was drawn from the logs of seamen of Phenicia.[8] It extends in the Atlantic from the islands off north-western Europe south to latitude 10° S showing the islands west of Gibraltar. Coming east it shows the seas and islands near the Red Sea and Persian Gulf. On the east side of Africa it extends to 15° S, about the same as on the west side. Further east it shows Ceylon the Peninsula of Malacca and still further east a body of water Ptolemy calls *Magnus Sinus;* now called Pacific Ocean. Ptolemy blocks the sea-route to the north on the east side of Asia by land; he runs the land away east from the south end of Africa and then north until it joins the east side of Asia, making what we call the Indian Ocean a land-locked sea and shutting off access by water between this sea and China. This is Ptolemy's great blunder and it is difficult to understand why he made it for the Periplus written before his day gives no color to it nor does the Itinerary of Pausanias of the same date.[9] As this imaginary coast comes north to join the east of Asia about where Java is Ptolemy places a city he calls Cattigara. Very likely the source of Cattigara was Java, for sea-traffic is very old thereabout and Ptolemy had reports of it. No part of the map of Ptolemy is exactly right. There was in the day no way to measure longitude except by walking along or sailing along keeping account of courses and distances.[1]

THE WAY SEAMEN OF THE DAY OF PTOLEMY HANDLED RUNS OF SHIPS.

The way of using the run of a ship now to be given must be the way of ship-masters and pilots though found in the writings of Ptolemy: "In determining the position of Sera," he wrote,[2] "Marinus had made use of

[8] See p 578 v 2 Bunbury's Anc Geog for this map.

[9] Above as to Periplus and Pausanias' work. There must exist a desire to complete things; maps were drawn about the day of Dias Da Gama and Magellan extending America south and then east across the S Atlantic until it met Africa.

[1] The maps of Sanson made 1668 A D 100 years before chronometers became available show the Mediterranean too long by one-third; Bunbury Anc Geog v 1 p 635: yet ships had made millions of voyages in that sea. See p 8 n 1 for remarks of Ruiter regarding mistakes in charts in 1641.

[2] V 1 p cxlvii Yule's Cathay 2 vs Hakl: see also below p 329.

the route of certain merchants who had travelled thither. xx The east extremity of the known earth is limited by the meridian drawn through the metropolis of Sinae at a distance from Alexandria of 119½° reckoned on the equator or about 8 equinoctial hours."[3] This is the earliest statement of the distance from West to East; though materially wrong it shows the route had been gone over, necessarily by ships. Ptolemy reduced courses and distances to differences of latitude and longitude in the manner we use; writing as to sailing between Palura on the east coast of India and Curura on the opposite side of the Bay of Bengal,[4] "The seamen and Marinus following them said the course between Curura and Palura took the direction of the winter-rising and that it was 9450 stadia xx. We subtract $^1/_3$ for deviations in the ship's course xx and then $^1/_6$ for the remainder for reduction to the parallel; which leaves for the interval between the [parallels through the] 2 places 5250 stadia. We then reduce these 5250 stadia in the proportion of 500 stadia to a degree and find the difference of longitude between Curura and Palura to be 10° 31′."

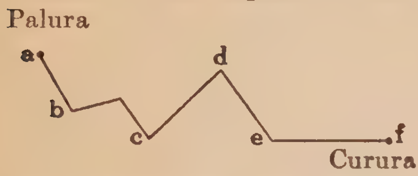
This is the oldest statement as to reducing a ship's course and distance run to difference of latitude and longitude. By winter-rising is meant the place the sun rises the day of extreme southern declination; it was generally taken to be what we name south-east though this is correct in one latitude only. The erroneous method was due to carelessness not ignorance for long before this day the bearings of heavenly bodies were known and tabulated and it was known the sun rises on different bearings in different latitudes. Thus it is difficult to follow what Ptolemy wrote about courses between Curura and Palura. Nor are we better off as respects distances. It was not until long after that confusion caused by differences in the length of the stadium league mile and degree was cleared away sufficiently to make it possible to compare the logs of ships; even

[3] The difference of longitude Alexandria to Canton is 83°: Ptolemy's figure is too great by more than 1/3, but it is to be observed the sea-route between the two is by no means straight and that neither Ptolemy or Marinus could have seen the log of a ship making the entire voyage: the figure they had was made up of shorter runs of a number of ships. See below p 234 for a measurement of this in about 870 A D.

[4] A trans of Ptolemy in Gosselin's Recher sur la Geog des Anciens p 116. There is an Italian trans of Ptolemy's Geography Venice 1598 wherein p 14 this passage is commented on by the editor Padouano: Padouano draws a right triangle as we would to explain and ascribes the use of this to Ptolemy. Gosselin gives a map of the locality under consideration. The words in the quotation below between square brackets—[ ]—are in Gosselin but the passage must better represent what Ptolemy meant if they are omitted. See below p 53 n 4 as to Palura.

now in measurements requiring close accuracy differences in standards cause difficulty.

It is worth while to examine Ptolemy's way of handling courses and distances. His date is 150 A D; he was a scientific man and improved and devised more than one astronomical instrument and method of plotting the earth on plane surfaces and wrote on astronomy as well as geography; his views if he could visit a modern observatory would be listened to with respect. In the statement it is taken a ship sails in a



broken line a b c d e f from Palura to Curura and the whole distance run on some such line is 9450 stadia. Ptolemy does not separately reduce each day's run as would be done today, possibly because they had not been reported; but says the ship ran 9450 stadia. Then he takes $^2/_3$ the reported length as the length of the straight line between Palura and Curura. This is possibly, but not certainly, assumption on Ptolemy's part; but perhaps—I make an assumption myself—this was a thumb-rule among seamen. He thus assumes the average of the inclinations of the parts of any line a b c d e f to the straight line between its ends is the angle whose cosine is $^2/_3$: this is 48° 12′. A modern ship should do better than this; if they have reasonable luck in winds and are well sailed they do not go a distance ½ longer than that to their port. If a ship has the wind dead against her always and can make good a course 6 points or 67½° from the wind she must run 5 miles to make good 2; it may be added that only a weatherly ship aided by good breezes and smooth seas can steer within 6 points. Ptolemy estimates the ship makes good 2 miles towards port by running 3; giving her nearly double what a capable sailing-ship of today can do in a wind dead ahead when aided by ideal conditions of weather and sea.

Sailing-ships have never and do not now work against foul wind in the open sea but follow routes where the wind is fair. In regions near Palura and Curura the monsoon blows and modern ships would hesitate to beat the 700 miles which separate the two. It is interesting to see how Ptolemy's rule to subtract $^1/_3$ to find the shortest distance works out: it will be found that if the wind is as likely to be in one direction as another all the way around the compass, which of course is never the fact, a ship will sail on the average 5 miles to make good 4 towards her destination; for every 100

miles made good towards port she must run 125 miles on a course as near the direction of port as she can lie. Ptolemy's rule is not much out;[5] he subtracts $^1/_3$ and here it is shown if the wind is as likely to be in one quarter as another $^1/_5$ should be subtracted. We do not know whether ships plying between Palura and Curura were fore-and-aft rigged or square-rigged. If the former they could look higher than a modern square-rigged ship; but if the latter and they had the bellying sail common in the day they could not have sailed within 6 points of the wind as modern square -riggers do.

So much can we make of Ptolemy's reduction of the broken line between Palura and Curura to the straight line. From the latter he subtracts $^1/_6$ to reduce it to a parallel of latitude; to obtain what we call the *departure* between Palura and Curura; the distance west and east on the parallel of latitude in their latitude. By taking $^1/_3$ from the 9450 stadia logged on the broken line the straight distance Palura-Curura is 6300 stadia; by taking $^1/_6$ from this the departure is 5250 stadia. In reducing the distance by $^1/_6$ to obtain the distance on the parallel of latitude it is assumed the angle between the Palura-Curura line and that west-east is the angle whose cosine is $^5/_6$. This is 33° 14′; that is, Curura bears E 33° 14′ S from Palura. Here we run into difficulty. Ptolemy says, "The *seamen and Marinus following them* said the course between Curura and Palura took the direction of the winter-rising." In latitude 15° S that of the locality the sun bears on Dec 21 at rising E 24° 21′ S. Here is discrepancy of 9°; for in reducing the line Palura-Curura to the line west-east, Ptolemy takes the bearing of Curura from Palura to be E 33° 14′ S. There is uncertainty about the latitudes of these places and the latitude 15° may be somewhat wrong; but in the low latitude this will not make much difference: the winter-risings in latitude 20° and 10° differ only 1° 13′. It looks as though Ptolemy may have had the bearing of the winter-rising at his place of residence Alexandria in Egypt in mind. The latitude of this is 31° 12′ and the winter-rising E 28° S.

Ptolemy reduces 5250 stadia in departure to difference of longitude measured on the equator. He reduces he says in the proportion of 500 stadia to a degree; dividing 5250 by 500, he says the difference of longitude is 10° 30′. He must have known all about this kind of thing for it

[5] The calculation has been made by Table 1 Bowditch; to shorten it every second point was included. Of the 16 points considered as wind-directions 11 allow the ship to steer for her port.

is a matter of projections and map-making; his strong point. If he meant there are 500 stadia to a degree at the equator, since this degree contains 60 geographical miles, he says there are $8^1/_3$ stadia in a geographical mile. But this is not quite the way to look at the matter. The calculation shows the departure between Palura and Curura is 5250 stadia. That is the distance between the meridians though Palura and Curura measured in latitude 15° is 5250 stadia; which makes that between the same meridians measured on the equator 5430 stadia.[6] Ptolemy leaves us in the dark as to the length of a stadium and does not notice the difference between departure and difference of longitude.

To follow Ptolemy's statement as to how courses and distances were handled is worth while if it is the way seamen used. He was too much a mathematician to have pitched upon the steps he tells us he took. They must have been the methods of seamen. They came home and said they had run so far between two places; they had no hourly and itemized record of courses and distances passed over. From this total distance sailed in directions as near that of their port as the ship would lie they subtracted $^1/_3$ and called that the distance between the places; the course was determined by the sun and stars and distances by means we are ignorant of except that Vitruvius describes an excellent log before the Christian era and says it was the invention, "Of the ancients" and Herodotus tells us 400 years before Vitruvius' day that a ship runs 130 miles in a day and measures distance on the earth by this.[7] Perhaps the seamen reduced this corrected distance to distance on the parallel by subtracting $^1/_6$ and perhaps this was Ptolemy's idea. From the fact that neither difference of latitude nor departure is calculated it might be presumed this too was the plan of the seamen. They reasoned perhaps that the run between Palura and Curura is a matter of longitude; the latitude-in is not worth the trouble of recording. If we had more complete records and in a variety of circumstances we could better understand. Marinus had great store from which Ptolemy drew. He must have had an office in Tyre; a Hydrographic Office. It existed before Marinus' day and to it returning skippers resorted with log-books and journals. When the Great Ocean Voyages

6 See Case II Parallel Sailing p 65 Bowditch ed 1848. The girth of the earth is 360°; in linear measure on a parallel of latitude it is less as we go from the equator. In 15° latitude the length between meridians whose difference of longitude is 1° is 57.96 miles measured on that parallel of latitude; measured on the equator it is 60 miles: table p 64 Bowditch.

7 Below p 49 as to Vitruvius' log: above p 38 as to Herodotus.

began the Spanish King established the Royal Office of Principal Pilot where from 1508 on a *Carta Padron Real* was kept posted correct to date as ship-captains made reports;[8] each ship being required to take a copy of the corrected Master-Chart.

Ptolemy influenced map-making until our day. Maps he drew or copies of these were in existence in 950 A D, for Macoudi an Arab of that day saw them and wrote,[9] "In the Geography of Ptolemy these seas are illumed in various colors;" and, "I have seen in the Geography of Ptolemy a drawing." Ptolemy's maps derived from Marinus and Phenician seamen are fore-runners of *portolans* the oldest real maps which have been preserved; the earliest of which was made 1300 A D. This one and others of the type are accurate and are believed to have been used by seamen and made by them; direction in them is accurate and it is believed the compass was employed in making them. Thus it is proved that from anterior to the Christian era seamen's charts have existed. Far back of Marinus' day a presumption practically a certainty exists and regarding the time from his day until now we have documentary proof in the fact that Macoudi saw Ptolemy's charts about 1000 A D and portolano charts of accuracy made not much later are now in existence.[1] The maps of Ptolemy prove chart-making was uninterrupted if those purporting to be his were in truth made by him, for though his maps would be of little service in ships, it would be a simple matter to draw good sea-charts from them. The curious pictures found in monasteries and palaces in Europe and reproduced as maps were of no service in ships.

VOYAGES OF UNUSUAL CHARACTER IN MODERN DAYS.

Voyages have been made in recent times in small craft partly provided. The number has been great and a few may be noted in the way of showing there is nothing impossible about them. A reproduction of the ship that found the American continent 1000 years earlier crossed the Atlantic in 1893; the boat of the British man-of-war Bounty, 23 feet long, voyaged west 4500 miles in latitude 10° in 1787; a ship's gig commanded by Lieutenant Talbot U S Navy came east in the Pacific 1500 miles in latitude 32° N in 1870; and the sloop Spray went around the world in

[8] Below p 295; Navarrete Colec Viages v 3 p 299.

[9] Prairies d'Or trans Meynard et Courtielle 9 vs Paris 1861, v 1 pp 185 and 204: below p 236.

[1] See below p 297 the Carte Pisane of 1300; Nordenskiold Periplus p 3–5 and pt 4 as to continuity of charts; below p 53 n 5 as to Ptolemy's maps.

1895–1898.[2] The Spray was 36 feet long and went around the world in the south-east trade passing Cape Horn and the Cape of Good Hope against the west wind. She had no chronometer and thus though she had charts and knew the seas and land she would near her navigational outfit was not much better than Magellan's. The only one of these voyages that had a fatal ending was that of Lieutenant Talbot; owing to long confinement and exposure it being the winter season the crew was much weakened and the boat wrecked on rocks near Honolulu all but one being drowned; Lieutenant Talbot was among those who lost their lives.

SHAPING COURSES AND PLOTTING POSITION IN EARLY DAYS.

Ships went and came for thousands of years before the Christian era and expeditions on which the lives and fortunes of princes and nations depended crossed wide seas and it is natural to enquire how the ships were guided. Maps were in use when our records begin and must have been in ships. Seamen were better pilots in ancient times than now; this comes from long seeking like wood-craft. As respects exact things, Herodotus writes down the daily run of a ship [3] and tells of the use of the sounding-lead and bringing up specimens of the bottom by it.[4] Any appliance likely to be thought of and of simple construction we may be sure was early in use. We have record of maps 5000 years ago[5] and record in 500 B C of ships making surveys over water;[6] but not until 1270 A D co-temporary mention of a map brought on the deck of a ship and the position and that of the port of destination pricked on it.[7] The Greek geographer Strabo erred when he wrote,[8] "Anaximander the disciple and fellow-citizen of Thales xx was the first to paint a geographical chart."

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[2] Romance of Discovery Griffis p 38; Bligh Voy Bounty; Last Cruise Saginaw Read; Sailing Alone Around the World Slocum.

[3] Above p 38: bk 1, 203 he measures the Caspian by ships' runs and bk 2, 11 the Red sea.

[4] Bk 2, 5, "If you let down a sounding-line you will bring up mud and find yourself in 11 fathoms of water": for a later case see The Acts of the Apostles, 27, 28. Nansen says Northern Mists v 2 p 251 the northmen recorded they found Iceland, "By probing the waves with the lead." The word translated *fathom* is in Herodotus *orguia;* it is the length over the out-stretched arms and the word was used by Homer 500 years before the day of Herodotus; Iliad 23, 327, Odyssey 9, 325. The same word is used by Herodotus in regard to speed; above p 38; it is still so used.

[5] Above p 21.

[6] Above p 22.

[7] Above n 5 p 6 to maps in Eastern ships in 1270 A D: below pp 428–9 as to chart used in a ship in 1270.

[8] V 1 p 13 Bohn ed in 3 vs: the date is 25 B C.

The date of Anaximander and Thales is 600 B C and maps of 3000 and 1500 B C are mentioned above. The famous description in Homer of Fashioning the Shield, " There he wrought the earth and the heavens and the sea and the unwearying sun xx " is a description of making a map.[9] Herodotus refers to the commonness of maps in his day writing,[1] " I cannot but laugh when I see a number of persons drawing maps of the earth without having any reason to guide them, making as they do the ocean stream to run all around the earth and the earth itself to be an exact circle as if described by a pair of compasses xx."

EARLY MEASUREMENT OF TIME: EARLIEST LOG.

Maps existed before our records begin and to make these courses and distances-run of ships had been recorded. The geographer Posidonius measured the circumference of the earth about 100 B C by the run of a ship between Rhodes and Alexandria.[2] To measure speed it is necessary to measure time and some 300 years ago speed was sometimes measured by walking aft as fast as bubbles or any object in the water came sternwards while singing a ditty; when the ditty was finished the walker stopped and the speed was judged by the length the observer had walked. The same thing was practiced by counting pulse-beats. These processes gave a more or less accurate time, but many centuries before the Christian era the gnomon sundial hour-glass clepsydra, all measurers of time, were available. In the Book of Isaiah is mention of a time-piece; the " Sundial of Ahaz; " the date of which is about 725 B C.[3] Any instrument depending on shadows requires rapid manipulation to serve in a ship but the hour-glass or clepsydra may easily be used. In Nearchus' Log 340 B C are such expressions as, " The first watch of the night " and in Homer the night is divided as always in Greek and Roman days and our own into 3 watches.[4]

In the writings of Æneas the Tactician is direction how to make a clepsydra run faster or slower. Æneas flourished in the day of Philip of

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9 Iliad trans Lang Leaf and Myers p 380.

1 Bk 4, 36. Note the mention of dividers; it has been supposed they are recent: see also bk 2, 109.

2 Bunbury Anc Geog v 2 p 95. See also pp 228–9 below as to Posidonius' measurement.

3 Ch 38, 8. See Breasted Anc Times pp 78 and 91; Oldest Surviving Astr instr and Oldest Clock in the World. Their dates are not fixed; both depend on shadows: below pp 57–8 in regard to Sundial of Ahaz.

4 Iliad Lang Leaf and Myers trans p 191.

Macedon the father of Alexander the Great and so was before Nearchus: writing of camp life he says,[5] "For the rest whether the nights are long or short that all sentinels shall be equally treated by regulating the length of their duty by the water-clock it is necessary to carefully coat with wax the interior part of the clock, and when the nights are longer to take away a part so that there may be more water, when they are short it is necessary to add some." It is reasonable to suppose ships used as good methods. The best evidence we have regarding measuring speed is in the work of Vitruvius written 25 B C: he tells of,[6] "One of the most ingenious things we have from the ancients. It is a means of knowing how many miles we have gone in a carriage or on the water." He goes on to explain how by a paddle-wheel and axle across a ship and train of gears with arrangement for dropping balls on a metal surface the speed is known; "By sound," he writes, "is made known how many miles on the water have been passed over." Such an arrangement would not be inconvenient in a row-vessel, the craft persons of consequence travelled in usually. Vitruvius says this was an invention of "The Ancients." In respect to light-houses buoys and other aids to navigation mentions occur in very old dates. The Pharos at Alexandria was built 300 B C and in place until 1326 A D.[7] Pliny writes of it in 75 A D,[8] "At the present day it directs ships in their course by means of the fires which are lighted at night on the tower." We have mention also of spar-buoys: Nearchus notes in his log,[9] "Huge posts or pieces of timber fixed here and there to point out the way in the same manner as those sea-marks on the Isthmus between the Island Leucadia and Acarnania to guide mariners in their course and prevent their falling among the shallows."

The best proof ships navigated the high seas in early days is that maps of large areas existed when our records begin, for these could have been made only from records of ships. In the Bible and Homer is evidence of runs in the open sea in early days. The passage in Proverbs, "She is like

5 Comm sur Defense des Places d'Aeneas le Tacticien trans Beausobre Amsterdam 1757 p 128. This book in Gr or Lat is in large libraries, but a search discovered the trans only in the library of Harvard College. It is in one volume there and the cat of British Museum shows there are two. Polybius says Æneas described improvements in making signals (see below p 177) but this is not in the trans at Harvard. See below p 54 as to difficulty of standardizing a time-piece.

6 Dix Livres de Vitruvius Perrault 2d ed bk 10, 14, p 317.

7 Breasted Anc Times p 262 for cut of the tower.

8 Bohn ed in 6 vs v 1 p 479.

9 Arrian's Exp Alex and Voy Nearchus trans Rooke 2 vs; they were near a place called Margastana.

the merchant's-ships she bringeth her food from afar," implies bold navigation,[1] and the statement in the same as to 4 things,[2] " Too wonderful for me xx which I know not," one being, " The way of a ship in the midst of the sea," shows it also. About 1000 B C when these were written ships of Syria struck out over-seas for their port: they did not to repeat an expression not unusual in describing ancient sea-going " creep along the shores." Homer is even more specific: in one place he writes, " Ten days and seven he sailed traversing the deep and on the 18th day appeared the shadowy hills," and in another, " Such men as know not the sea neither meat savored with salt." [3] The most interesting voyage in Homer is one from Crete to the Nile-mouth recorded thus,[4] " Nine ships I fitted out and the crews were gathered quickly xx; on the 7th day we set sail from wide Crete with a north wind fresh and fair and lightly we ran as it were down-stream, yea and no harm came to any ship of mine but we sat safe and hale while the wind and the pilots guided the barks. And on the 5th day we came to the fair-flowing Ægyptus and in the river Ægyptus I stayed my curved ships." The ships ran S E 330 miles in 4 or 5 days, an average of 83 or 66 miles per day. They might have followed the coasts of Asia Minor and Syria, which would have been further, but took the direct way; from which it may be concluded ships had been going from Greece to Egypt for centuries, the way having been found by coasting Asia Minor and Syria gradually going more and more directly until in Homer's time ships went straight: this shows that anterior to the date of Homer the eastern Mediterranean was surveyed and charted; that is before 800 to 1000 B C.

Kenrick [5] tells us Phenician seamen steered by a star nearer the pole than the one used by Greeks and Romans and applied astronomical science, " Practically to navigation combining with it the arts of calculation necessary in reckoning a ship's course." Strabo 25 B C must be the authority for this statement: Strabo writes Phenicians were the first to distinguish the Lesser from the Greater Bear the former being nearer the pole, adding,[6] " On the Phenicians specially designating and employing it

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[1] See above p 14.

[2] Ch 30, 19.

[3] Odyssey pp 84 and 176 trans Butcher and Lang: see also pp 136, 154, 155, 230, 231, same ed for other passages as to long stays at sea.

[4] Odyssey p 230 ed cited note next preceding.

[5] Phenicia p 235.

[6] Bk 1, 1; p 4 v 1 Bohn in 3 vs. A foot-note adds the Lesser Bear was made known to the Greeks by Thales about 600 B C and that the Greeks called it *phoinike*, indicating Phenician origin of their knowledge. The Latin poet Ovid wrote about 25 B C, " Ye Bears both the Greater and the Less which the one guides the Greek the other the Sidonian ship;" Tristia p 327 v 1 Bohn in 3 vs.

in navigation it became known to the Greeks." In the Pharsalia of Lucan is a statement that ancient seamen steered by holding stars on the rigging as is done now: when at Mitylene in a ship he writes,[7] "Here always the Lesser Bear xx stands on the ropes of the main-yard; then do we look towards the Bosphorus." The Bosphorus is north of Mitylene, and the star would stand thus when looking from the stern of the ship.

DETERMINING DIRECTION AT SEA.

Ovid makes a statement about steering which is misleading: he is describing sun-rise and says,[8] "Before thy rising the sailor better observes his constellations and wanders not in ignorance in the midst of the waves." Stars near the pole move little and are convenient to steer by while the sun because it is too bright and moves fast in azimuth, cannot be used. So far Ovid's statement is correct but if it implies ships could not obtain by the sun the bearing of the pole it is inaccurate. Before his day it was possible to find the compass-bearing of the sun by an observation with an astrolabe and thus the ship's course would become known. We have no mention of a ship having done this but they were supplied with appliances tending to safety and knew how to use these. Such an observation would occupy a few minutes.[9] The earliest mention of steering by stars is in the Odyssey and as follows,[1] "The Bear xx which turneth ever in one place and alone hath no part in the baths of the Ocean; this star Calypso the fair goddess bade him keep ever on the left as he traversed the deep." The hero was bound east and the pole would be on his left. All navigators have used stars to steer by. The Polynesians called the one used *aveia* and since they have western compasses call them by this name.[2] The motion of stars has been observed since remote antiquity and it was noted some move very little during even an entire year. As we look abroad the stars at our pole are the only motionless points visible; many years ago this was observed, not as matter of curiosity and research but as furnishing a datum necessary in life. As regards this a well-known author has written,[3] "The whole evidence proves conclusively the pole-star was watched in India from 21000 B C when it was first a star in

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[7] Pharsalia Bohn p 301; bk 8, 171: Lucan was executed 65 A D.

[8] P 294 v cited note 2d above.

[9] Below p 58.

[1] P 84 Butcher and Lang trans.

[2] Polynesian Researches Ellis v 3 p 167. Prof Newcomb Astron for Everybody p 42 writes, "At the present time the pole-star is a little more than a degree from the pole. The pole is gradually approaching it and will pass it in about 200 years."

[3] Hewitt Hist and Chron Myth-Making Age p 39.

Kepheus and that a record of the changing pole-stars was kept and registered by the nations living around the Indian Ocean and in Syria and Egypt."

RECKONINGS OF SHIPS.

In Kenrick's statement quoted above [4] he refers to knowledge of Phenicians of, "Calculations necessary in reckoning a ship's course:" his authority for this must be Strabo who wrote,[5] "The Sidonians xx cultivate science and study astronomy and arithmetic to which they were led by the application of numbers in accounts and night-sailings each of which branches of knowledge concerns the merchant and seaman." The application of numbers in night-sailings is necessary because a reckoning is more necessary by night than day. There were always merchants on board accompanying their wares to their destination,[6] who if sailors were not accountants could supply the deficiency; for arithmetical processes were familiar in very early days.[7] There are proofs that ships kept reckoning: Strabo says Hipparchus rested his determination of the relative position of Gibraltar and Sicily,[8] "Entirely on the assertion of sailors." Hipparchus must have known for he is the greatest mathematician and astronomer of antiquity that only in this way could position be fixed, unless he sent a party to *walk* from Gibraltar to Sicily and reduced its courses and distances as those of ships are reduced. The ship was much the better way; if supplied with the log Vitruvius says the ancients used [9] the distances found would have been nearly correct, and if courses were kept by observations of the sun and stars by astrolabe the bearing between the 2 places might be determined as accurately as today by a ship's run. The ship or men walking around by land would record courses and distances which would constitute a continuous line in a number of directions, which when reduced would be the distance and bearing between

[4] P 50.

[5] Bohn in 3 vs bk 16. 2, 24.

[6] The first steps to free merchants from this are very old: govt com agents or consuls were appointed as early as 500 B C, and foreign letters of exchange were in use in India as early: see below p 70 Consulat de la Mer v 1 pp 579 and 612.

[7] Hist Anc Egyptians Breasted p 419; p 93, by 3000 B C, "The Egyptians had already roughly mapped the heavens xx and developed a system of observation and instruments sufficiently accurate to determine the position of stars for practical purposes xx. In mathematics all the ordinary arithmetical processes were demanded in the daily transaction of business and government and had long since come into common use by the scribes."

[8] Bk 2, 1, 11. Hipparchus' date is 150 B C.

[8] Above p 48.

the places. This process must have been followed by Hipparchus or his agents.

Pliny whose Natural History was written 79 A D has a passage of interest as regards reckoning; "Those who sail to the west xx go further," he says,[1] "because they go in the same direction as the sun." Perhaps this is a statement of abstract fact; but if the result of observation it is amazing for the length of the day when west-bound was not more than 30 minutes in excess of that east-bound. If 2 ships ran 10 knots per hour east and west their runs of about 240 knots would differ only 5 knots. Much later Heliodorus who flourished about 400 A D tells of an occurrence which shows a reckoning: passengers who express anxiety about pirates because a smaller vessel is following in the wake of theirs are informed,[2] "It is a very common thing for small ships to follow in the wake of larger ones for the sake of being directed in their way." Vessels meeting at sea now hang black-boards over the side with the latitude and longitude written thereon. There is not however data to enable us to say exactly how seamen reckoned. Even of the methods of Ptolemy the Geographer we are in partial ignorance as will have been concluded from what has been said,[3] yet his Geography was accomplished probably by maps and tables giving latitudes and longitudes, but as it was not printed for centuries it is uncertain if the maps in modern editions are Ptolemy's.[4]

DETERMINING LATITUDE.

In some editions of Ptolemy latitudes are stated in terms of the length of the longest day of the year.[5] This measurement could be made on one day only of the year and the means of measuring were poor, while by an altitude at noon of any heavenly body whose declination was known or altitude of a star near the pole latitude could be quickly determined. The method by measurement of the length of the day was useless for seamen;

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1 Bohn in 6 vs v 1 p 106; Pliny was a Roman admiral.

2 Romances Heliodorus Longus and Achilles Tatius Bell p 121.

3 Pp 41–6.

4 Bunbury Anc Geog v 2 p 578. At this opening is Bunbury's Map of the World According to Ptolemy. In some copies of Ptolemy's maps at Palura on the west side of the Bay of Bengal this legend appears, "The point of departure of navigators sailing to Chryse"; that is to the Peninsula of Malacca: see Bunbury v 2 p 604 note 4. The distance across the Bay of Bengal is about 700 miles: above pp 41–6.

5 In a Latin copy printed Basle 1547; longitudes are also in hours and minutes. Bunbury Anc Geog v 2 p 572–3 says Ptolemy gave 26 maps in all; 10 of Europe 4 of Africa 12 of Asia.

it was noted by a clepsydra or sand-glass turned quickly. How were these instruments standardized? Sand-glasses are now standardized by taking from them or adding a little sand as indicated by a watch. Æneas the Tactician about 350 B C tells how to make clepsydra run longer or shorter but does not allude to making them show time correctly.[6] There is nothing in the ancient authors to show how they standardized a time-piece: yet they must have done it; a day at the equinox is 12 hours and so much water or sand would run through a hole in that time; $^1/_{12}$ part was water or sand for one hour and $^1/_{60}$ of that again for a minute.[7]

An early voyager Pytheas of Marseilles determined latitude in Britain in this way about 325 B C;[8] Julius Cæsar and the Emperor Severus used it in 55 B C and 210 A D respectively; Ptolemy and presumably Marinus of Tyre used it in making their maps in 50 to 150 A. D; and we have record of its use in India about 1291 A D.[9] The endurance of this process is inexplicable for much better ways were available. For example; there is a difference of 6 minutes in the lengths of the longest days between latitudes 39° and 40°; that is one minute change in the day corresponds with 10 miles change of latitude and a clepsydra or sand-glass could not measure as close to this. Then also how were these to be set right, with what compared to know they were running true. The difficulty as to moment the sun rose and set must be considered too for these vary with the state of the atmosphere. In spite however of short-comings the process was used as just stated and also by Columbus in the West Indies.

Ptolemy's latitudes were many by the height of a celestial body for he writes,[1] "Hipparchus alone and that in the case of a few cities only in

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6 Above p 48. So complex and perfect is our method of keeping time that we little realize how dependent it is on the motion of celestial bodies; how intolerable our condition would become if we could no longer reckon by astronomical instruments. It is not necessary to conceive our time-pieces wrist-watches and great astronomical clocks to be taken away; it would not be long before they were at variance. Yet the world went on without them until 200 years ago.

7 It would be useless to note time by weight or volume of sand or water; time must be determined for longitude much closer than to one minute which at the equator is 15 miles of longitude.

8 Below p 63.

9 The authority for Cæsar is Comm Gallic War bk 5 chap 13; see also below p 650; for Ptolemy Bunbury's Anc Geog v 2 p 573; for Emperor Severus Foster's Dio's Rome v 5 p 385; and for use in 1291 A D, below p 256. See also table n 1 p 650 below.

1 A trans of Ptolemy's words in Bunbury's Anc Geog v 2 p 554: the extr there is much longer; it is very involved but its meaning is evident. Hipparchus was of 150 B C.

comparison with the vast multitude of those that must find a place in a general map had transmitted to us the elevations of the north pole and the positions of places under the same parallels. A few of those who have written since his time have added notices of certain places situated opposite to each other, not as being at equal distances from the equator but as being on the same meridian; a fact established by the voyage from one to the other being a straight course before a north or south wind. The distances from one place to another have for the most part been reckoned only in a rough and general way especially those from east to west; not so much from the carelessness of those who reported them as from their want of mathematical skill and the small number of simultaneous observations of lunar eclipses at different places that had been duly recorded; like that which was seen at Arbela at the 5th hour and at Carthage at the 2d xx." He states latitude was by, "The elevation of the pole;" but it should not be concluded the height of the *pole star* which is equal to the latitude of the observer was used. At the present the altitude of the sun or other body when on the meridian is generally observed for latitude, being preferred because the pole star is not bright and a better horizon is available by day. To use meridian altitude for latitude the body's declination, angular distance from the quarter, must be known; and before the time of Hipparchus all this was known and the declination was available. Until recent times navigators often wrote latitudes as "heights" and it has come to be believed that only in the day of the voyages of the Portuguese south when ships lost the pole star was the method of finding latitude by meridian altitude of the sun made available by preparation of tables giving declination.[2] There is however no doubt this is erroneous as tables of declination were in existence many centuries before the date of the Portuguese voyages: [3] as will be apparent they could be prepared without calculation by daily observation of the meridian altitude of the sun at a place whose latitude had been ascertained.

Ptolemy's longitudes are less accurate than his latitudes. He tells in the extract just given he derived the former by the runs of ships east and west and observations of the beginning and ending of lunar eclipses. The last appear at the same absolute moment at all points and it is necessary only to note the local hour in places whose longitudes are desired.

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[2] Below p 63 for Champlain's use of word *height* for latitude and below p 533 as to Barros' reference to declination when the Portuguese ships went far south.

[3] Below p 238.

Ptolemy noted the sun's height at the moment of an eclipse and thus found the local hour of the day.[4] If a sand-glass or clepsydra could be relied on [5] the moment of the eclipse read by these would be an easier way, but an error of one minute throws the longitude out 15 miles, enough to land a ship on the rocks and an error likely to occur in the use of these appliances.

THE ASTROLABE.

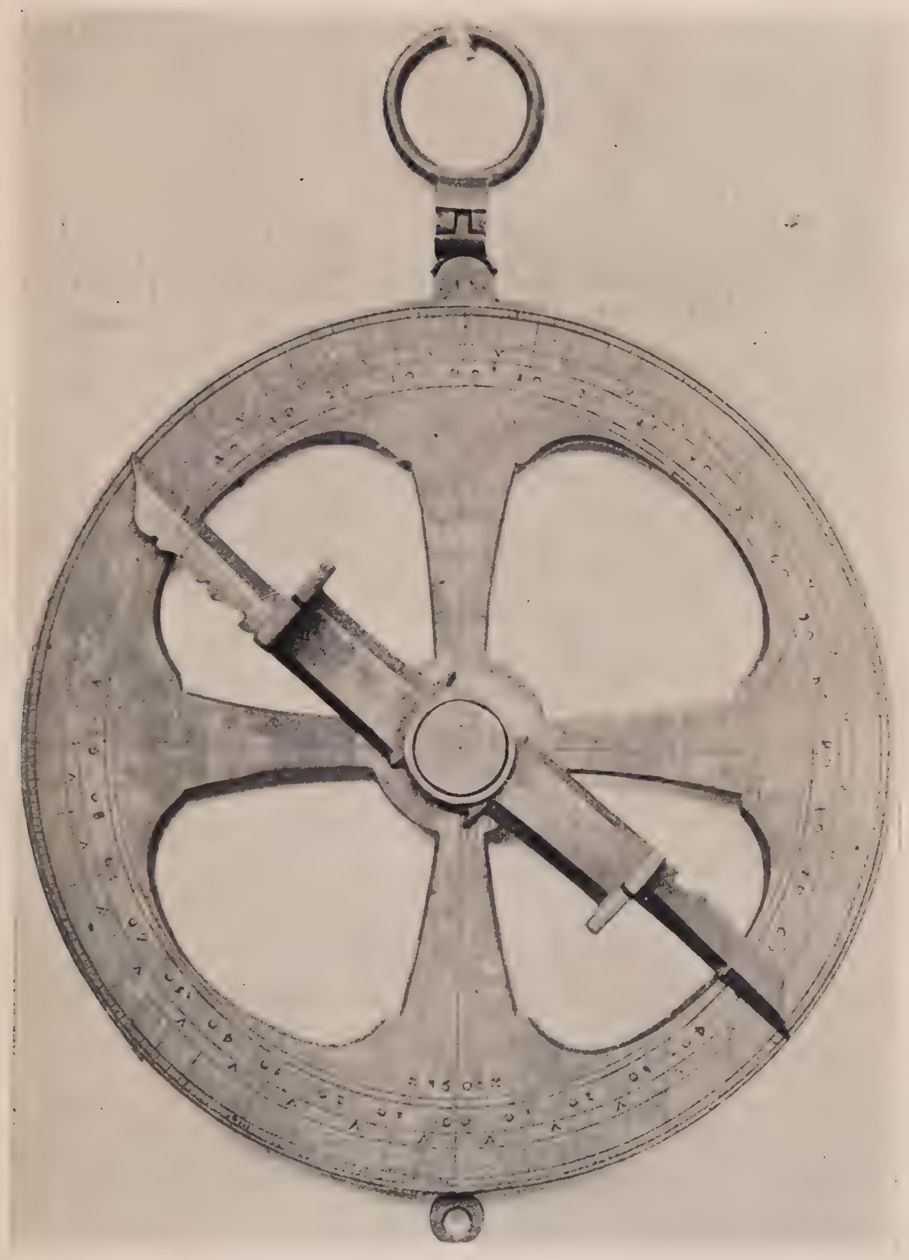
The astrolabe is the simplest possible instrument for measuring angles; consisting as it does of a circle whose circumference is gradated and a bar lying across the circle and pivoted at its center. The observer held the instrument suspended freely by a ring on its circumference and directed the sights on the bar to the body whose height he wished to measure; the angle between the direction of the bar and the horizontal line on the astrolabe gave the angle. When large and suspended on land on a tripod they were accurate. We have their history for 2500 years fragmentary but continuous, and because it is at least 5 or 6 thousand years since men began to measure angles and the astrolabe is simple in theory and fabrication it must be still older. The *name* is not heard however until about 350 B C. They lasted long for Champlain used one in America and lost it in 1613; it was found not long since. Fournier a French author wrote about 1667, "It is impossible to find a better instrument than the astrolabe."[6] They measure angles, heights of celestial bodies and could serve to direct ships in the open sea failing only in cloudy weather. Ships did not use compasses before 1000 or 1100 A D and during a long period anterior astrolabes were probably used to give the points of the horizon by the sun or star, but the first written mention of an astrolabe in a ship is of date 1275 A D [7] and the first of one in use afloat in the day of Columbus and Magellan. In early times seamen were less dependent on instruments than now. Many could tell the north or other point of the horizon by a glance at sun or stars and the hour by the same means; the last being much esteemed because necessary to carry out plans. As the ancient world was in a narrow belt of latitude bearings of celestial bodies were little disturbed by changes in latitude and observations made throughout a year in one place at particular hours sufficed to form tables which could be used anywhere; which method could be applied by those

[4] Below p 9.

[5] Below p 66 as to Celestial Chronometer of Hipparchus.

[6] Below p 62 as to Champlain's astro; p 371 Fournier's Hydrographie for words quoted; picture here inserted for Champlain's astrolabe.

[7] Below p 491.



The picture is from Russell's Champlain's Astrolabe Lost June 7, 1613, Found August 1867; see n 6 p 56. The instrument is 5⅝ inches diameter, the same size as Columbus, Da Gama, and others used. It is without the systems of lines, *arachne* or spider's-web, found on many instruments, and being for the graphic solution of astronomical problems.

unwilling or unable to calculate bearings. The results of such observations engraved on gnomons sun-dials or astrolabes, served to determine graphically direction the hour of the day and other quantities.

THE SUN-DIAL OF AHAZ.

The oldest written mention of using the shadow of the sun to determine the hour is in the Book of Isaiah and as follows,[9] "Behold I will bring again the shadow of the degrees which is gone down in the sun-dial of Ahaz 10 degrees backward. So the sun returned 10 degrees by which degrees it was gone down." Ahaz was King 735–715 B C and his sun-dial in or near Jerusalem. The Prophet records the miracle of reversing the motion of the sun, his words showing the shadow of the sun gave the hour. Herodotus wrote 300 years after, "The sun-dial and the gnomon with the division of the day into 12 parts were received by the Greeks from the Babylonians."[1] Herodotus derived his astronomy and mathematics from the priests in Egypt and that he should have been told these instruments came from Babylonia shows they were deemed very old.[2]

There was then in 725 B C a sun-dial showing time by the sun; the position of the end of the shadow of a vertical shaft showed the time. There was marked on it for each hour of each day a position on which the end of the shadow fell and only one. When the instrument was made and marked it was placed in the sun and turned until the end of the shadow came to the point belonging to the actual day and hour; or if this could not be done by calculation and in advance the instrument could be set up and the positions of the shadow's end for each hour of each day through a year be observed and marked. When this was done the sun-dial was set for use. It was as accurate as the sun but had 2 faults; though accurate it could not be closely read since a shadow's limits are not precisely defined; it was useless at night and in cloudy weather.[3] The shadow of the end of the vertical bar showed the hour, the long edge azimuth of the sun. The

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[9] Ch 38, 8.

[1] Bk 2, 109.

[2] See Smith's Dict of Bible word Ahaz as to probability knowledge of astron in Syria was from Babylonia. The word hour meaning 1/12 of a day came into common use in Greece about 150 B C. If this indicates time-measurers gave time only within an hour they were useless to measure longitude; for an hour is 15°, 900 miles at the equator. See words *hora* and *horologium* Smith's Dict Gr and Rom Antiq.

[3] The motion of the moon the only body other than the sun capable of casting a shadow is very complicated and was not completely determined until 1750 A D when finding longitude by it became possible.

north was marked by the instrument: it could serve to steer a ship. It was too heavy to set up onboard ship, its vertical shaft and dial being masonry work very large and massive, but the lines and marks on it upon transference to a smaller and portable instrument,[4] to an astrolabe, could do this. A practiced observer could use a small copy of the sun-dial of Ahaz, an astrolabe, in a sea-way and determine in a fraction of a minute the points of the horizon the hour of the day the latitude; all the quantities necessary to guide a ship except longitude. Only when the heavens were obscured would this fail.

To use the astrolabe to determine the points of the horizon the hour or latitude it is necessary to know the declination; that is the angular distance of the body observed from the equator. If this could not be computed it could be found by measuring the meridian altitude on each day: from this the latitude of the place—known, as a place onshore is assumed—being applied, the declination is quickly found. A table of declinations through the year being formed the pilot carries it with him. It is a mistake to suppose any art advances by great leaps; that until the day of Portuguese navigators ships never left the land, until the compass went afloat about 1100 A D ships were blind as to direction, and until 1800 A D longitudes were guessed. In the long years things were developing the astrolable played the major part. It is not accurate at sea [6] and could not be relied on to give direction nearer than ½-point but with it all problems of navigation could be solved. Nowadays after observing the navigator takes pencil and paper and tables of several kinds and works his observations out; while by lines on astrolabes this could be done and the result known in a fraction of a minute.

A TREATISE ON THE ASTROLABE IN 650 A D.

In 650 a treatise on the astrolabe was written by Severe Sabokt;[7] a scientific work giving solutions of problems of navigation. In the time of Sabokt and thereabouts astrolabes were used in every-day life for in the Arabian Nights we are told of a barber who goes out of his shop to take an observation with his astrolabe to see if the time is propitious to shave

[4] It probably consisted of a vertical shaft of masonry standing in a depression the sides of which were in 12 steps or *degrees*. By the word *degrees* the Prophet means steps in the depression surrounding the vertical shaft: as the sun moved the end of the shadow passed quickly from one step or degree to the next; a device for reading the great clock.

[6] Below p 331.

[7] Below p 238.

the head of a customer.[8] Sabokt does not explain how to find the points of the compass though this could be done by his instrument, but this is fully explained by Chaucer who wrote a similar treatise about 1300—on the same class of instrument it should be observed.[9]

ALTITUDES FOR LOCAL TIME: THEIR EARLY AND PRESENT EMPLOYMENT: LONGITUDE BY ECLIPSES.

The altitude of a heavenly body furnishes the hour. These were used in early days and may be taken at sea or onshore being called *time-sights*. Practiced men can work them out in 10 minutes or less, or if an astrolabe is used the place where the sun's image falls on the instrument gives the hour immediately. It was understood in remote times that at places whose difference of longitude is to be found by an eclipse the time at which the eclipse occurs must be noted at each place, when the difference of times gives difference of longitude. There was no clock before 1800 accurate enough to give time as closely as it must be known; but time-sights were employed for this purpose in early day. Thus the ancients were able to determine longitudes by observing time of eclipses, but the process was without value at sea and for travellers in general unless they had another local hour with which to compare their own. At present when work of this character is to be performed observers are sent to various points and times observed; to rely on those dwelling in various places seems never to have been practiced. To work in this way requires the eclipse shall be predicted so that preparation may be made, and the earliest record of this is the Eclipse of Thales predicted by that astronomer as to occur in 585 B C, but no difference of longitude was determined from this. In 331 B C the hour of the occurrence of an eclipse at Carthage and, "On the banks of the Tigris" was observed and from these it resulted that the difference of longitude was 3 hours. The "banks of the Tigris" is not a definite point, but the difference of longitude from Carthage to the Tigris is $2^1/_3$ hours.[1]

[8] Ed Lane 3 vs 1865 v 1 p 332.

[9] Below p 243.

[1] There are 3 famous eclipses of ancient times: one occurred June 15, 763 B C, being recorded on stones of Nineveh; another is the one predicted by Thales in 585 B C (see Newcomb Astronomy for Everybody p 143 as to these); and the third was in 331 B C. As to the last there is no statement it was predicted; only that by it the difference of longitude mentioned above was determined: see Bunbury note p 417 v 1 and p 14 v 2.

The plan of making observations of the same eclipse at many places was not put into effect until 1577 A D when Philip II of Spain ordered it to make a map of his possession in the West Indies Mexico and South America. Although his control included the Philippine and Molucca Islands on the far side of the globe he does not seem to have included them in his world-survey.[2] Ptolemy used large astrolabes hung on tripods too heavy and large to carry which would be very accurate, with peep-sights; *dioptra* the Greeks called these.[3] Besides astrolabes he used an instrument called a *parallactic ruler* and measured altitudes to determine local time.[4] That Ptolemy measured altitudes to determine the hour, took time-sights as would now be said, should not be over-looked. We shall find the Arabs took them in mediæval days.[5]

THE FORE STAFF OR CROSS STAFF.

We hear of this in the day of John Davis the Navigator but the parallactic ruler of Ptolemy of which we hear no more after his day was much the same. Ptolemy's instrument consisted of 2 bars jointed at one end and a third jointed to one of these: one jointed bar was directed to the zenith by a weight the other by peep-sights to a heavenly body; the angle between the bars was the zenith-distance of the heavenly body and was read by a scale on the third bar. This may have been the germ from which grew an instrument Da Gama found in the hands of Arab seamen when he reached Eastern waters. It is described by the Portuguese historian Barros as, "An instrument of wood of triangular figure," he adds it was of, "Three boards."[6] To make Ptolemy's ruler usable at sea and in effect

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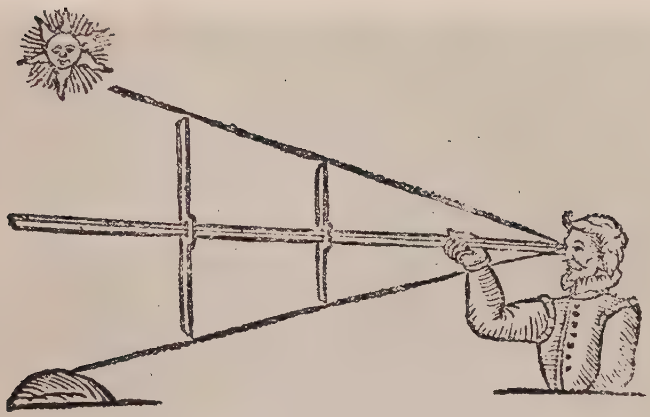
[2] Below p 628.

[3] See Rogers Diss on Knowledge of Anc in Astr and Optical Instr p 32 for an attempt to show Pythagoras 500 B C was familiar with telescopes: it turns on translation of the Greek word *dioptra*. If Pythagoras was familiar with telescopes the art of making them was subsequently lost for they were not common before 1600 A D; see below p 647. In Layard's Ruins of Nin and Babylon Res of 2d Exp p 196 is recounted the discovery of, "The most ancient known specimen of transparent glass": its date is 700 B C and close by it was found, see p 197 same v, "A rock crystal lens with opposite convex and plane surfaces": a foot-note states this gave on measurement a good focus. This is still far away from a telescope, but there is no reason to discredit the story of a lens at Nineveh abt 700 B C for they were not uncommon a few centuries later.

[4] Montucla Hist Mathematiques 4 vs v 1 p 307: a figure of the paral ruler is given.

[5] Below pp 237–8.

[6] Barros, Asia, 1, 4, 6; p 320 v 1 ed 1778. Barros wrote about 1550. See also p 343 below.



Cross-staff or fore-staff in use; the picture is at p 263 Davis' Seaman's Secrets bound with Davis Voyage, Hakluyt: see p 345 below for Davis' Back Staff.

the same as a fore-staff it would be necessary only for an observer to direct the bar usually kept on the zenith to the horizon.

PTOLEMY AND PORTABLE ASTROLABES.

Ptolemy explains the construction and use of astrolabes.[7] Those used on land were large and supported on a rest. They were unfit for use in a ship, and we are told,[8] "Because of the size xx and excessive cost and expense of this xx Ptolemy is wisely persuaded for the good of all to take and use another instrument of less cost." Many astrolabes have been made and in many countries and numerous treatises on their use have been written.[9] They were in use 2000 or more years an age compared to which that of present instruments is insignificant and the number of observations made with them is very great. In Evans' work cited in note next above it is stated Eudoxus of about 350 B C invented the astrolabe, which view is taken probably from Vitruvius whose date is 25 B C and who wrote, "The astrologer Eudoxus invented the web."[1] In a footnote to the word web the translator of Vitruvius writes, "If this web is that which is upon astrolabes as there is strong appearance it is described hereafter in the same chapter under the name *horologe anaphorique*." Vitruvius says also on his page cited, "There have also been persons who have made for those who travel portable dials." Surely there must have been portable dials in possession of travellers by ships who would know how to use them. What more likely if the ship had been driving 3 or 4 days, "following the wind" the ancients called this, without seeing sun or stars, than that a learned and curious passenger should recover direction with his instrument. Those belonging in the ship would thus learn how to establish direction if indeed they did not know before, but no statement exists that this occurred.

Vitruvius says Eudoxus invented the web, the system of lines on sun-

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[7] Almagest trans Halma v 1 p 283; bk 5 ch 1.

[8] Traite de Comp et Fab de l'Astrolabe trans from Latin of Stofler Paris 1570 p 67. This author quotes Messahala the principal Arabian authority on the astrolabe as saying, "Know that astrolabe is a Greek word."

[9] Evans Eur and Orient Astrolabes Arch Jour v 68 2d ser 1911; many astro are illustrated. There are in coll in Eur some 300 astrolabes, the oldest of 950 A D. See below p 243 for notice Chaucer's Treat on Astrolabe.

[1] Dix Liv trad Perrault 2d ed 1684 p 285 bk 9 chap 9. "On the Constr and Use of Watches [that is Sun-dials and Clepsydra] and How and by Whom They Were Invented. The word *web* is in the French *araignée* and Latin *arachne,* the last being really Greek. These words all mean *spider's web;* and very like one are the lines on the plate of an astrolabe by which were solved problems now solved with logarithms.

dials and astrolabes, shadow-instruments in general, for telling the hour azimuth etc by sun or star; but the sun-dial of Ahaz in use 400 years before would do this.[2] The discrepancy should cause no surprise for it is unlikely Vitruvius had read the writings of Isaiah. All instruments for measuring angles at sea must be used quickly and modern instruments are not free from objection on this score. Gnomons have never been used in ships, but astrolabes, much the same as gnomons except that those intended for seamen could be held hanging in the hand, were long employed. Ships carried them until 1700 A D; so they were afloat perhaps for 2000 years. Yet they have an almost fatal fault. On land if large and made true they are accurate, but it is otherwise in ships. The observer onshore takes his time in a ship he must be quick. In ships the astrolabe was held suspended on finger or thumb by a ring on the upper part of its circumference, being light and small. All parts of the observer's body including that on which the astrolabe hangs are in motion, often violent, as the ship rolls and pitches; thus the point of suspension of the astrolabe is never still and the instrument never stands vertical. By so much as the instrument is out of the vertical by so much the angle it shows is in error. When *cross-staff* and later *Davis' back-staffs* came to be used this cause of error was removed;[4] for these instead of relying on the force of gravity to keep them true are held on the horizon. All modern angle-measurers for ship-use include this. The error of instruments which depended on hanging vertically must frequently have been as much as 5° which in an observation for latitude by pole star or meridian altitude would throw the latitude out the same amount; about 300 miles. The journals of Portuguese pilots about 1500 show they judged astrolabes often gave errors of 4° to 5° in latitude.[5]

CHAMPLAIN'S ASTROLABE.

A very interesting thing is the astrolabe used by Champlain in the northern part of this country and lost there in 1613.[6] It is a circle of

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[2] Above p 57.

[4] Just above as to fore-staff or cross-staff and p 345 below as to Davis' back-staff. The last is the most note-worthy instrument ever devised for use in ships; Davis was himself a seaman. Ptolemy's parallactic ruler being dependent on gravity to hold it true had the same fault as the astrolabe; but the instrument used by Arab pilots described by Barros if held true by directing one of its three "boards" at the horizon would have been free from this error: see just above.

[5] Below p 339.

[6] Champlain's astro, lost 1613 found 1867, Russell; a photo is given. See picture p 56 above.

brass $5\frac{5}{8}$ inches in diameter $\frac{1}{8}$ inch thick at top and $\frac{3}{8}$ at bottom. There is at the top a ring flexibly jointed to the circle by which to hold it suspended. A bar carrying sights is pivoted in the center of the circle and the graduation is to single degrees. The suspension ring was usually held on the left thumb of the observer who sometimes steadied himself by leaning against a mast. In Champlain's Journal found with his astrolabe several latitudes are recorded which though the astrolabe is graduated to degrees only are to single minutes. They were measured onshore and are nearly correct. One records reads, " *Je prins la hauteur de ce lieu qui est par les 45° 18′.* " This is a latitude though it is said, " I took the height of this place." The angle stated is the height of the pole as well as the latitude; people of Champlain's day spoke in this way and confusion may thus arise but for years the word height meant both latitude and observed height. We do not know what body Champlain used; but if the sun his best means as he must have known the angle his instrument showed—necessarily from the south and not north, from which he would measure the pole star —was between 22° and 68°.[7]

PYTHEAS OF MARSEILLES.

A famous navigator of ancient times was Pytheas a Greek who dwelt in Marseilles. He went north in 325 B C, not far from the time of Eudoxus the reputed inventor of the astrolabe, and is said to have measured 5 latitudes, those where the length of the longest day is 15, 16, 17, 18, 19 hours; in our scale, 41°, 49°, 54°, 58°, 61°. This would have occupied 5 years as it would have been necessary to have been in each latitude on the day of the summer solstice; but because Pytheas was an astronomer it has been believed he observed by other method and converted into longest days.[8] It would be satisfactory to know in what way the ancients observed. Of the results there is no doubt and these together with what we know of the

[7] It is assumed he used a meridian altitude; as he was in 45° N latitude the sun was south. Being onshore he must have used a reflecting horizon; a lake river or pond would have served. The ancients used reflecting horizons; marking the meridian passage of stars by their reflection in water at the bottom of wells. This they did by both day and night.

[8] Pytheas of Marseilles Discoverer of Britain Markham Geog Jour including Proc Roy Geog Soc v 1 Jan—June 1893; Anc Geog Bunbury v 1 p 589. Pytheas determined the lat of Marseilles his result being very nearly correct but we do not know what method he used; about 200 years later Hipparchus determined the lat of Byzantium, making it the same as Marseilles. In this he erred for Byzantium is $2\frac{1}{4}$° south of Marseilles. Hipparchus is said to have used a gnomon or sun-dial in making this observation; Bunbury v 1 p 661.

instruments give a good idea. Perhaps no ancient instrument is so striking as the sun-dial of Ahaz. It measured angles and solved problems of astronomy but there were systematic astronomical observations ages before the time of Ahaz.

THE OLDEST FIXED DATE; IN ITS ESTABLISHMENT ANGLES IN THE HEAVENS AND INTERVALS OF TIME WERE MEASURED.

The date 4241 B C is fixed by Egyptian astronomers for in that year they had determined the days in the year; had counted the days while the sun makes a revolution among the stars, in how many days it returns to its former position among them.[9] For how many years did preparation for this continue and to what problems did it lead? Observations had gone on many centuries before astronomers even began to count the days in the year. It is not altogether simple, for the stars are not visible at the time the sun is: the way they proceeded is this; each evening and morning after the sun set and before it rose stars which had not been seen at the previous sunset or sunrise would appear or would have disappeared and these were noted.[1] Stars situated within a certain angular distance from the sun cannot be seen and as the sun moves some appear while others disappear between two sunsets or sunrises. The disappearance of stars into the zone so near the sun they could not be seen within a certain time after sunset and before sunrise and reappearance therefrom gave means of following the sun's motion.

The exact operations are not recorded; but they must have included measuring angles, charts of the heavens must have been made, and many things must have been learned, such as that the altitude of the pole is the latitude of the place, the meridian altitude of any body when its declination is applied is also the latitude, etc. To show angles were measured:—on any night certain stars not visible before appear at twilight on the horizon, the next night others appear. The vertical angle between stars appearing one night and the next would be about 1° because the sun moves about 1° in a day. A measurement of the vertical angle

[9] Breasted Hist Anc Egyptians p 15; "The calendar year of 365 days was introduced in 4241 B C the earliest fixed date in the history of the world as known to us."

[1] Vincent Com and Nav Anc in Indian Ocean v 1 p 545 writes, "xx The times when stars rose or set with the sun when they set as the sun rose or rose as the sun set. This xx was esteemed by the ancients of the utmost importance; xx by this they regulated their festivals judged of the return of the seasons and even estimated the length of the year." There are many works on early astronomy; Narrien, Bailly, Biot, etc.

between 2 stars which appeared at 2 successive sunsets or sunrises if we suppose observations exact determined the year. If noting appearance or disappearance of stars was free from error and the angle between them correctly measured this angle gives by dividing it into 360 the days in the year. The astronomers must have known this and have measured the angles between stars and compared observations made on successive days. By the process outlined if conducted so as to exclude constant errors, and a great multitude of appearances and disappearances of stars noted and angles between those of successive nights observed; the average would give the length of the year. Determination may have been reached by counting the days in which a circumpolar star comes back to the same position at the same hour, or the days in which the sun, observed by threads held vertical by weights, returns to a former azimuth,—the same thing could be done by a tube containing cross-hairs at each end, a dioptra. In this last the sun should be observed when nearly east or west at which epoch its change in azimuth is most rapid.

Two stars which appeared or disappeared on successive nights were about 1° apart east and west, $^1/_{360}$ the circumference: since the Babylonian method of dividing the day into 24 parts was used these crossed the meridian or rose or set at intervals of $^{24}/_{360}$ in time; as we would say $^1/_{15}$ hour, 4 minutes. This cannot have escaped the astronomers: it is possible that by meridian passage of stars closer together, 1, ½, ¼ minute apart, hour-glasses and clepsydra were set true.

NAUTICAL ASTRONOMY.

Nautical astronomy is that part of the science used at sea. It cannot be that ancient navigators did not use it; that they did not measure angles; did not find direction the hour of the day or night and latitude by pole-star and meridian altitude. Their instruments were the gnomon sundial astrolabe, all nearly the same, and clepsydra and sand-glasses. We know astronomers understood nautical astronomy but have no explicit statement the science was applied in ships.[2] In longitude ships were badly

[2] The nearest is a case of crossing land: Pliny v 1 p 392 Bohn in 6 v writes, "Polybius states the distance from Carthage to the Lesser Syrtes the one which is nearer to it to be 300 miles. The inlet to it he states to be 100 miles across and its circumf 300. There is also a way to it by land, to find which we must employ the guidance of stars and cross deserts which present nothing but sand and serpents:" perhaps though the stars were used only to guide direction; not to fix position. This was written about 70 A D.

off because the clocks hardly deserved the name and the motion of the moon very rapid and changing the only means used for longitude at sea could not be predicted. It has just been seen that the establishment of solar year leads to knowledge of astronomy and Hipparchus about 150 B C made a list of 44 stars scattered over the heavens at intervals of right ascension—distance east or west from a fixed point—equal to one hour of time; and examination of his figures shows his average error is one minute of time, 15 miles of longitude.[3] It is not stated he noted the hour of meridian passage of these but if he did he went far toward making it possible to determine longitude, for a comparison of this hour with that of meridian passage of the same star on the same day of the year at any other place would give difference of longitude. If Hipparchus had had means of measuring time he would certainly have done this, for it must all have been known to him, but his means for this were wretched. He may have observed the altitude of another star as his stars crossed the meridian and thus deduced the hour of meridian passage. Not much later Ptolemy the Geographer observed in this way for time and Hipparchus must have known the hour could be thus determined. He would have needed besides the altitude he observed the latitude of the place of observation and declination of the star he observed, and these he could have determined if indeed they were not already recorded. All this might have been done in Hipparchus' day 150 B C and no doubt long before, but we hear of it in no way until 17 centuries pass, until when Vespuccius and other scientific seamen tried to find out where their ships were. In the day of these latter we have the oldest scientific records of seafaring written by the seamen themselves, and perhaps if such records in days nearer to Hipparchus existed we should find attempts of similar character.[4]

We have no satisfactory statement ships found position by astronomy in ancient days and know only that appliances were available and that then as now ship-captains were expected to do the best possible: the Greek orator Demosthenes argued about 350 B C,[5] "As if when a shipmaster has provided everything for its security and furnished his vessel with every instrument which he supposes may contribute to its preservation and after that she meets a storm which disables her or even totally destroys

[3] Le Chronometre Celeste d'Hipparque p 25 no 1 Copernicus an Inter Journ of Astronomy, Schjellerup; see also Time in Enc Brit 11th ed.

[4] Below p 575 for a longitude by Vespucius in 1503.

[5] Or Æschinus agt Ctesiphus and Demosthenes de Corona trans Portal, p 259.

her the wreck should be imputed to his fault." In Xenophon whose date is the same we find evidence of care in other lines; a visitor who has been onboard a Phenician ship recounts,[6] "I must tell you what strikes me as the most accurate arrangement of goods and furniture it was ever my fortune to set eyes on when I went as a sight-seer onboard the great Phenician merchant-ship. xx The pilot's-mate was examining and I asked him what he was doing. He answered I am inspecting stranger the way things are lying onboard the ship. xx There is no time left you know when God makes a great tempest in the deep to set about searching for what you want xx."

FINDING A PORT BY BIRDS.

The use of birds at sea is mentioned by ancient writers but the allusions are of mythical character and it may be doubted if the process was much employed. "The Athenian planters," we are told,[7] "built the city of Cumæ. They were conducted in this voyage by the flight of a pigeon or some say by the sound of a musical instrument." Homer has early navigators guided in more picturesque manner; "The Phæacians," he writes,[8] "have no pilots nor any rudders after the manner of other ships but their ships understand the thoughts and intents of men." Pliny about 70 A D says the people of India,[9] "Carry birds out to sea which they let go from time to time and so follow their course as they make for the land." In Scandinavia also birds were used in this way.[1] There is a record showing deep sea navigation in the East by the aid of birds; it runs,[2] "Long ago the ocean-going merchants were wont to plunge forth upon the sea onboard a ship taking a shore-sighting bird with them. When the ship was out of sight of land they would set the shore-sighting bird free. And it would go to the east and to the south and to the west and to the north and to the intermediate points and rise aloft. If on the horizon it caught sight of land thither it would go. But if not then it would come

[6] Xenophon Dakyns trans v 3 pt 1 p 236, The Economist. The vessel it will be observed is a merchant ship, a round-ship. The passage is much longer than here given.

[7] Rom Hist Paterculus trans J P. The author was 20 B C; Cumæ was on the site of Naples the first Greek settlement in Italy founded 1000–800 B C.

[8] Odyssey Butcher and Lang p 133. Herodotus bk 1, 163 says the Phæacians were the first Greeks who went long voyages; see p 13 above.

[9] Bohn in 6 vs v 2 p 52. Pliny was admiral of a Roman fleet when he wrote but does not say his ships carried birds.

[1] Nansen Northern Mists Chater trans v 1 p 248–250.

[2] Roy As Soc Journ 1899 new ser v 31 p 432; Rhys Davids.

back to the ship again." This passage belonging in 450 B C shows deep-sea sailing is very old in the Far East; there are older voyages recorded in the Mediterranean but the waters are narrower.

THE CARRYING TRADE OF THE MEDITERRANEAN IN 1000–700 B C; PIRACY; WARRING ON THE SEA.

Before 1000 B C merchant-ships in the Mediterranean were Phenician and Egyptian and by 700 B C these had given place to Greek ships. The Greeks imitated the vessels of their fore-runners perhaps improved them and being of war-like character put afloat fighting ships. That fighting on the sea was common in these days we have proof: Thucydides writes,[3] "Trieres are thought to have been built first in Greece at Corinth. It appears too that Aminocles a Corinthian ship-builder also constructed 4 such vessels for the Samians. Now it is about 300 years from the time when Aminocles went to the Samians to the end of this war." He means the Peloponnesian War; as this ended 405 B C, trieres were first built in Greece in 705. The date of the Phenician biremes, 2-oars,[4] on the sculptures of Sinacherib is very nearly the same. We see here steps of war-like nature in Greece and the east of the Mediterranean and the battle off the Nile-mouth in 1200 B C is evidence of the same;[5] the ships opposed to those of Egypt are from the north. In these days there was an island-empire whose center was Crete, which occupies a position of great advantage for trade or preying on passing vessels. Crete was early the seat of a civilization which in recent years only we have become acquainted with.[6] About 1200 B C Minos was King in Crete: Thucydides writes,[7] "Minos was the most ancient with whom we are acquainted by report that acquired a navy and he made himself master of the greater part of what is now the Grecian Sea, and as was natural he swept piracy from the sea as much

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[3] Bk 1, 13. In Eng trans the word *triremes* is used, not *trieres;* but Thucydides wrote trieres this being Greek and trireme Latin: both words mean *three-oar*. Thucydides implies there were trieres elsewhere at earlier date.

[4] Above pp 33 and foll'g: Greeks said diere not bireme.

[5] Above p 31: the term *war-ship* occurs on monuments of Egypt of 2500 B C; above p 33.

[6] Baikie Sea-Kings of Crete p 133 says in Zakro in the eastern end of Crete, "In one single house of one of the merchants were 500 clay seals xx evidently used for sealing bales of goods:" this is taken to indicate 500 customers of this merchant; see p 224 Baikie. Baikie fixes the date of this as earlier than that commonly received for Minos: p 145 Baikie's work it is indicated ships plied between Crete and Egypt in 4000 B C.

[7] Bk 1, 4–5.

as he could for the better coming in to him of his revenue. For the Greeks of old time xx after they began to cross over more commonly to one another in ships turned to piracy xx as this employment did not yet involve any disgrace but rather brought with it something of glory."[8] Early piracy is shown by Homer; he says it was customary to hail ships,[9] "Whence sail ye over the wet ways on some trading enterprise or at adventure do ye rove even as sea-robbers over the brine, for they wander at hazard of their lives bringing bale to alien men."

At later date Aristotle shows how public revenue was added to by piratical cruises; "The Carthaginians," he says,[a] "having numerous mercenaries in their city whose pay they were unable to discharge devised the following measure; they gave notice that if any citizen or resident alien had or wished to have a license to make reprisals on any foreign state or individual he should register his name. In consequence of this many persons having registered they plundered with a fair pretext all ships sailing into the open sea; a time being appointed for giving account of the prizes. A large sum of money having been thus collected the soldiers were paid and dismissed and a judicial inquiry was made respecting the prizes after which a satisfaction was made from the public revenue to those who had been unjustly plundered."

During 1000 to 700 B C the Greeks took over large parts of the carrying trade until then enjoyed by Phenicians and Egyptians. By the time of the Persian invasions of Greece beginning 490 the Greeks held this trade for in years following 700 Phenicia was over-run by armies and before the Persians sent an expedition to Greece they conquered Phenicia and called on her for ships to transport the army. Persia was probably led to attack Greece because of Phenician reports of her wealth and in the expeditions of invasion Phenician ships carried the Persian men horses supplies and baggage. Without the ships the Persian army could not have moved. Because of circumstances of this character before and after the Persian invasions rivalry became sharp and war on the sea between Greece Phenicia Egypt and perhaps other nations became continuous. Long before 500 B C war on the sea was organized and for centuries after was continuous. The contestants were not the same; as one nation was

[8] Below p 250 as to piratical empire of much later date near Java.

[9] Odyssey Butcher Lang trans p 33: the date is 900 B C.

[a] Heeren Hist Res Africa v 1 p 153 Eng trans: see just below as to 2 treaties between Carthage and Rome; in one of these it is laid down, "The Romans shall not sail in search of plunder beyond xx."

exhausted another took its place. In the opinion of some similar conditions in the Pacific may lead to like consequences unperceived by the nations who have a stake in the outcome.[1]

TREATIES AND CODES OF LAWS.

Treaties are recorded on the monuments of Assyria and Egypt and one between Hiram of Tyre and King Solomon in reference to Building of the Temple is in the Bible. The date of the last is about 1000 B C; the passage regarding it reads, "Then Hiram the King of Tyre answered in writing which he sent to Solomon xx; we will cut wood out of Lebanon xx and we will bring it to thee in floats to Joppa and thou shalt carry it up to Jerusalem."[2] In 509 and 348 B C treaties of commerce were made between Rome and Carthage and in 215 between the great Hannibal and Philip King of Macedonia.[3] Military commanders afloat and onshore made treaties in ancient days. The treaty cited was made by Hannibal while commanding in Italy. Polybius tells of one about 165 B C, the negotiations to be, "Solely on the initiative of the *navarch;* the *navarch* having by the law the power to act in such a case."[4]

Codes of laws prove over-sea intercourse in very ancient day. Of those extant that of Hammurabi is the oldest its date being about 2000 B C.[5] This had its origin in Babylonia and contains laws regarding traffic at sea. The Code of Manu was drawn up in India about 1000 B C and in it what we call *bottomry bonds*, contracts by which money is loaned on sea-voyages, are mentioned, and rates for travel by ship on rivers but not on the high seas are fixed.[6] Thus covering the risk of a sea-voyage is the oldest description of insurance. Letters of exchange also took rise in commerce at sea [7] and as the sea was for long the only way

[1] Widney Race Life Aryan Peoples v 2 p 180, "What the Mediterranean was until the 2d and 1st centuries B C, what the Atlantic was to the 17th and 18th centuries, the Pacific seems fair to become for the 20th. xx The Pacific is the world's last and greatest sea-prize for rival and contending nations."

[2] Second Chronicles 2, 11–16; First Kings 5, 8–12.

[3] The text of these will be found in app 2, 3, 3, pp 474–78 Heeren's Researches Africa. See as to the subject generally Barbeyrac Hist Anc Traités and Eggers Etudes Hist sur Traités.

[4] Polybius Shuckburgh trans bk 30, 5; Torr Rhodes in Anc Times p 47; Polyænus Stratagems of War trans Shepherd 2d ed p 245, for a similar case about 300 years nearer our date. A navarch was commander of a fleet.

[5] Code Hammurabi, Harper.

[6] Pardessus Coll Lois Mar Ant au 18 ieme Siecle 6 vs, v 6 p 387: Vincent Comm and Nav of Anc v 2 p 404. See p 526 below.

[7] Above p 52 n 6.

by which persons and commodities could move from place to place many methods of conducting business at a distance had beginning there. Statute Law though the sea was frequented by pirates was operative on the sea at least as early as on the land. The words of the Roman Emperor Antonius Pius 138–161 A D may be cited; "I rule the land but the law rules the sea. Let the matter be judged by the naval law of the Rhodians so far as our laws do not conflict with that."[8] There was a body of maritime law at early date similar even in regions most widely separated.[9] A fluid nature in sea-affairs we find everywhere and as to all things; ships and their rigging sailors and their ways are similar.

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[8] Rhodes in Anc Times Torr p 52: the authority is The Pandects XIV, 11, 9. Torr adds, "Probably much of the maritime laws of our day has come down from the Rhodians. Nothing of these laws is heard at Rhodes itself:" see Ashburner's Rhodian Sea Law and Parson's Rhodian Law.

[9] Pardessus v 6 p 374. This v deals with law in the Indian Sea Malacca and Asia.

CHAPTER II.

LONG-SHIPS.

How They Rowed; The Effect of Throwing-Machines on Ship Construction; Navigation.

Long-ships were the war-ships and carried light freights short distances, at which time they had only part-crews of rowers; passengers went by them because they made comfortable passages, running by day from one port to the next giving opportunity to sleep and eat onshore and lying in harbor when the weather was bad. Round-ships struck out across sea for their final destination, and thus made good passages when there was a lasting breeze, but were liable to encounter foul weather and be delayed. Long-ships did all the fighting; even in the open rough seas near Britain and in the hands of the Northmen they composed the line; round-ships were in war-fleets carrying stores and provisions and used in special ways but were rarely in the line-of-battle. There is record of passengers going by both long- and round-ships until a late day; [1] both Christian and Turkish fleets at the Battle of Lepanto in 1571 were composed mainly of long-ships; while the fleet sent by Spain against England in 1588 the Spanish Armada and the English fleet opposed to it were round-ships. Fleets of all European nations including the far-away Northmen were in the Holy Land during the Crusades and their line-of-battle-ships were long-ships.

The passing-away of the long-ship in war fleets came principally because of improvements in the masts and sails of round-ships, which from about 1400 rendered them more handy and better able to evade the ram-charge of long-ships: this, together with numerous guns on the broadsides, made round-ships too much for the earlier class of war-ship. Also because of these improvements round-ships carried passengers more and more; being handy and weatherly they gave quick and safe despatch. But war-ships looking like row-ships of Greek days could be seen until 1700 A D; Fournier writes in 1667 of 3-deck war-ships thrusting oars from their 3 lines of gun-ports and putting 5 men on each to reach advan-

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[1] Below pp 481–83 as to voyages of long-ships about 1300 and 287 about 1400.

tageous position,[2] and shows that arming long-ships was matter of concern; " The arming of long-ships," he writes,[3] " is very different from that of round-ships." It seems also that the rising price of human labor, diminution of the number of slaves, and increase in humanizing influences as years went by had effect in rendering it impossible to operate ships with oarsmen. It is recorded that Madame de Sevigne in about 1675 her daughter having described by a letter what she had seen onboard a row-galley replied she, " Would like to see such a hell." No-one today would say as much—and as little.

THE PERIODS OF OARS SAILS AND STEAM.

The period of the oar-ship was from pre-historic days until 1700 A D if we take the date established by Fournier, or somewhat later if we follow another French writer, Admiral de la Gravière, who states the French Royal Galley Corps was abolished in 1748.[4] This long rule of the oar certainly 3000 years in duration and probably much longer has been called the Oar Period, but it should be remembered the term applies only to fighting and packet ships, for during these days round-ships were propelled by sails and were the burden or merchant's-ships. Admiral de la Gravière writes again,[5] " Navies have known only one golden age, the one in which the wind skillfully controlled was made to do the work. This golden age is contained between 2 ages of iron, the age of the oarsman and that of the fireman." The period when the oar was the motive power in battle is replete with interesting and instructive things and presents many points of likeness to the period we are in; that of steam. The Period of Sails Admiral de la Gravière's golden age was short; only from 1550 when ships were sufficiently well masted and rigged to make them handy until 1850 when steam power came in. The length of time the oar was used in battle is 10 times that of sails. The long-ship of former days more than once saved civilization from destruction or serious retardation: The defeat of the Persians at Salamis 480 B C saved Greece and ships of East Rome, of Byzantium, by overcoming Mahometan fleets in 640–677 saved eastern Europe from becoming Saracen or enduring the blight of Saracen rule as

[2] Above p 29.

[3] Hydrographie 2d ed p 95.

[4] Dern Jours Mar à Rames p 115; see pp 9, 37 same book life in galleys rowed by slaves: also p 514 below.

[5] Mar des Anciens v 1 p 169.

Spain did.[6] It is generally said the progress of the followers of Mahomet in Europe was stopped by the battle of Tours in 732 and seldom is their earlier check at Constantinople alluded to. Without the success of fighting-ships in controlling the Mediterranean the over-sea commerce which brought to Athens and Rome wealth and power, and later to Constantinople Venice Genoa Pisa Spain and Portugual could not have flourished.

THE WAY OARSMEN WERE PLACED.

When ramming became common, before 1200 B C if we accept the History of Herodotus,[7] speed and handiness became important. Speed could be gained by making ships light of sharp and contracted form below-water and putting in more oarsmen. They could not be lengthened because that lessens handiness; so oarsmen were crowded into ships without adding to length. Rowers were packed very close; Xenophon a Greek wrote about 400 B C,[8] "Picture a triere crammed choke-full of seamen; for what reason is she so terror-striking an object to her enemies and a sight so gladsome to the eyes of friends? Is it not that the gallant ship is so fast? And why is it that for all their crowding the ship's-company cause each other no distress? Simply that there as you may see them they sit in order in order bend to the oar in order recover the stroke in order step onboard in order disembark?" The Roman statesman Cicero wrote 350 years later,[9] "When a ship is manned as it should be with rowers and soldiers it is impossible to place onboard not a few men but a single man more." In this respect fighting row-ships were always the same: Barras de la Penne, a

[6] A fleet sent from Byzantium by the Emperor Constans 641–68 was defeated by a Saracen fleet off Phenix in Lycia but the Saracens gained nothing. In 672–77 the Saracens invested Constantinople; their ships were driven off and armies reduced to impotence by East Roman fleets; at this time we hear first of Greek Fire, see below pp 376, 435 and foll'g. Though the sea is an unbroken level plain, several sea-battles have in many instances been fought at the same place: nearly 700 years before the Battle of Phenix Pompey the Great commanding a fleet of Old Rome defeated the pirates of the Mediterranean at the same place. Phenix is in the Gulf of Adalia in the south coast of Asia Minor.

[7] Above p 31 as to pict of 1200 B C on monuments in Egypt and Herodotus 1, 166; Thucydides notes this writing of Herod in bk 1, 10.

[8] Dakyns trans 4 vs v 3 pt 1 p 235; The Economist.

[9] Verres 5, 51: Cicero was killed 43 B C.

ERNEST THORIN, éditeur. A. Quantin, imp.

BAS-RELIEF DE L'ACROPOLE D'ATHÈNES REPRÉSENTANT LA PARTIE CENTRALE D'UNE TRIERE.

A modern 3–oar in the Far East: from pl 9 Captain Pagè's work in the Fr ed of 1782. See also p 11 Adm Paris' Musee du Louvre, and his Essai sur la Constr Nav des Peuples Extra-Europeen pls 103 and 104 where Pagè's illustr are reproduced. The last is a very handsome volume of illustr: it is in the N. Y. Public Library.

French sea-officer who died 1750 A D, wrote of them;[1] "From poop to prow you see only heads xx. The captain and the officers are hardly better lodged. xx When caught by gales in the Gulf of Lyons xx the galley becomes a hell. The lugubrious lamentations of the oarsmen the terrifying cries of the seamen the horrible screams of the galley-slaves the groaning of the timbers and noise of the chains of the slaves mixed with the roaring of the tempest, produce sentiments of terror in the hearts of the most intrepid. xx Even a calm has its inconveniences. xx There are always in galleys certain little bugs that cause much suffering. Flies by day bugs by night fleas and lice by day and night xx, the frightful vermin respects not cardinals ambassadors or even crowned heads."

For more than 3000 years oarsmen were closely packed in long-ships; galleys they were called in mediæval days. We can follow their operations without knowing how the men were placed, can know something of their speed and handiness understand their tactics in battle their capabilities and limitations in operations of peace and war; further than this our knowledge will probably never go, for it is unlikely we shall learn exactly how oarsmen were placed. They were packed so close that men could not live onboard in the way we live in ships and the way the ancients lived in round-ships; both crews and passengers had meals and slept on the land if possible, doing this even when an enemy's fleet was within a distance which could be covered in a fraction of an hour;—a thing which must ever be a marvel to people of our day. Only when galleys came to be rowed by slaves chained to their thwart did the oarsmen live in them; under circumstances of much privation it need hardly be added for they could move only a few feet and could not lie down. This came about 1500; brought about by the ever-lengthening oars necessary to drive ships ever-larger and the laborious nature of this work; and thus in about 1500 *scaloccio* rowing, alluded to above, in which each oar was long and heavy and handled by many men became general. Before 1500 rowing was managed in 2 other ways, which may be shortly described as, (1) placing rowers close one above the other (2) placing them close one alongside the other,

[1] Gravière Dern Jours Mar à Rames p 9. This passage belongs in a period when all rowing was *scaloccio,* long oars pulled by 5 to 7 men chained in place. Barras wrote also about ship-building but I have been unable to find copy of his work. He should not be confounded with the Comte de Barras lieut-general de marine who 30 years later served in the fleets of d'Estaing and de Grasse on our coast;—"In the maritime war undertaken by France for the independence of the United States" as La Rousse's Grand Dict has it.

on the same level thwart. In both each man pulled his own oar and as all space throughout the stroke was occupied by oars and oarsmen great skill was necessary in crews. Scaloccio rowing, heavy oars with several men on each, though not to be undertaken by unpracticed crews was simpler, and the difficulty in finding men to row in more complicated ways is said to have been in part the cause of adoption of long heavy oars.

What we know of ships comes from figures on coins, vases, monuments, and after 500 B C from history books. In mediæval days there are illustrations on charts, books, and paintings executed to commemorate great events. The story presents contradictions and breaks in continuity; the illustrations are seldom satisfactory for often the artist has taken so great liberties as to render them useless or nearly so and the written texts are at variance in many cases. Yet a conception of ships and their ways may be reached. The illustrations we accept if we believe them truthful; as to the texts, when we read of a *so-many*-oar ship—often the only description is in 3 or 4 words—what are we to conceive her to be? Were her oarsmen one above another each pulling his own oar; abreast each other, all at one height, each pulling his own oar; or does *so-many* mean the number of men on each oar supposed long and heavy? No one of these can be wholly accepted and the other wholly rejected.

LIVY DESCRIBES ROW-SHIPS.

Livy a reliable Roman writer mentions,[2] " A royal galley of a size almost unmanageable being moved by 16 banks of oarsmen." This ship was sea-going for when thus mentioned she was on the coast of Macedonia and Livy mentions her 30 years later when in the Tiber River.[3] If the 16 banks were one above the other the tholes of upper oars were 30 feet above the water and the longest oars more than 100 feet long, as long as the main-yard of a 50-gun ship of a few years since. If abreast in the same horizontal plane, arranged in a way to be immediately described, there would be 32 men, 16 on each side, seated on a thwart extending across the vessel. As each man occupies about 2½ feet the ship's beam would be 80 feet her length in the neighborhood of 800 feet and some oars would be 50 or 60 feet long. Thus 16 banks of oars cannot be used one over the other nor one within-board the other in the same level. Livy wrote in defining

[2] Baker trans 33, 30: his date is 20 A D. The words quoted are the only ones in regard to how the vessel was rowed.

[3] Same 45, 35.

the class of the vessel only that she had *sexdecim versus remorum.* Versus means a line a row, so the phrase means 16 rows or lines of oars. But perhaps the word *remus* had come to mean *oarsman,* in which case we might suppose all oars in one level and each pulled by 16 men, which if we suppose 8 men on the fore side of the oar and 8 on the after would mean a ship of 40 feet beam 400 feet long and oars not less than 60 feet long each handled by 16 men. The vessel could not have been driven at good speed with less than 100 oars on each side, which would call for 3200 rowers. She is not an impossibility if we suppose her rowing managed in this way, a way called in Italy in later day *scaloccio.*

HERODOTUS DESCRIBES ROW-SHIPS.

There is in Herodotus a passage which is curious regarding placing oars and as to discipline: it falls in about 500 B C, and is as follows;[x] the commander of a Persian fleet, " Went his rounds to visit the watch onboard the ships and found a xx vessel on which none was set. xx He made his guards seek out the captain one Scylax by name and thrusting him through one of the holes in the ship's side to bind him in such a way that his head might show outside the vessel while his body remained within xx ." This indicates in some small measure that oar-ports were at more than one level; it may be added that an opening large enough to pass a man's head through would be larger than necessary to pass the loom of an oar.

ZENZILE ROWING.

The oar-ports for this would be wide enough to let a man's head pass. They would be all in one level and probably above the vessel's rail. In zenzile rowing a certain limited number of men were on each level thwart, each one pulling his own oar—a system rejected just above as impossible with as many as 16 banks. This system was universal in Italy and throughout the Mediterranean in 1200 A D. It must have been used for material time before that date since it was then universal; but the evidence is clear only as to the year 1200 and that it was used until 1500 when replaced by scaloccio. The name zenzile was used to mean this way of rowing and scaloccio to mean rowing with one long oar in each oar-port

x Bk 5, 33: the expression *hole in the ship's side* is in the Greek original *thalamie* which means the hole for oars of *thalamites,* the rowers on the 3d or lowest bench; see note p 240 v 3 Rawlinson's trans Herodotus.

with several men on it.[4] When rowing zenzile thwarts were level and had the inboard end further aft than the outboard end; each man pulled his own oar and oars passed sternward of all men outboard—that is in front of them; the oars of all men on each thwart passed through one port in which was a separate thole-pin for each oar. The investigations of Admiral Fincati in Venetian dock-yards leaves no doubt that zenzile rowing was used in Venetian ships about 1200 A D and was replaced by scaloccio rowing about 1500.[5] The Admiral must believe ships of the ancient Greeks rowed zenzile; for he calls Venetian triremes, "Those hardy triremes which stopped the invasion of the Turks as 20 centuries before Greek trieres their ancient sisters stopped the invasion of the Persians."[6] He cannot mean both the old and later 3-oar vessels rowed scaloccio, with long oars and 3 men on them, nor that both rowed zenzile, men all at one level and one within-board the other; the first because we cannot but conclude that Greek vessels rowed some other way than scaloccio and the second because his own investigations prove that when the Turks were stopped at Previsa and Lepanto, 1539 and 1571, zenzile rowing had been replaced in Italy by scaloccio. That at Salamis 480 B C and Previsa and Lepanto 2000 years later war-vessels rowed in the same way is impossible in view of the record.

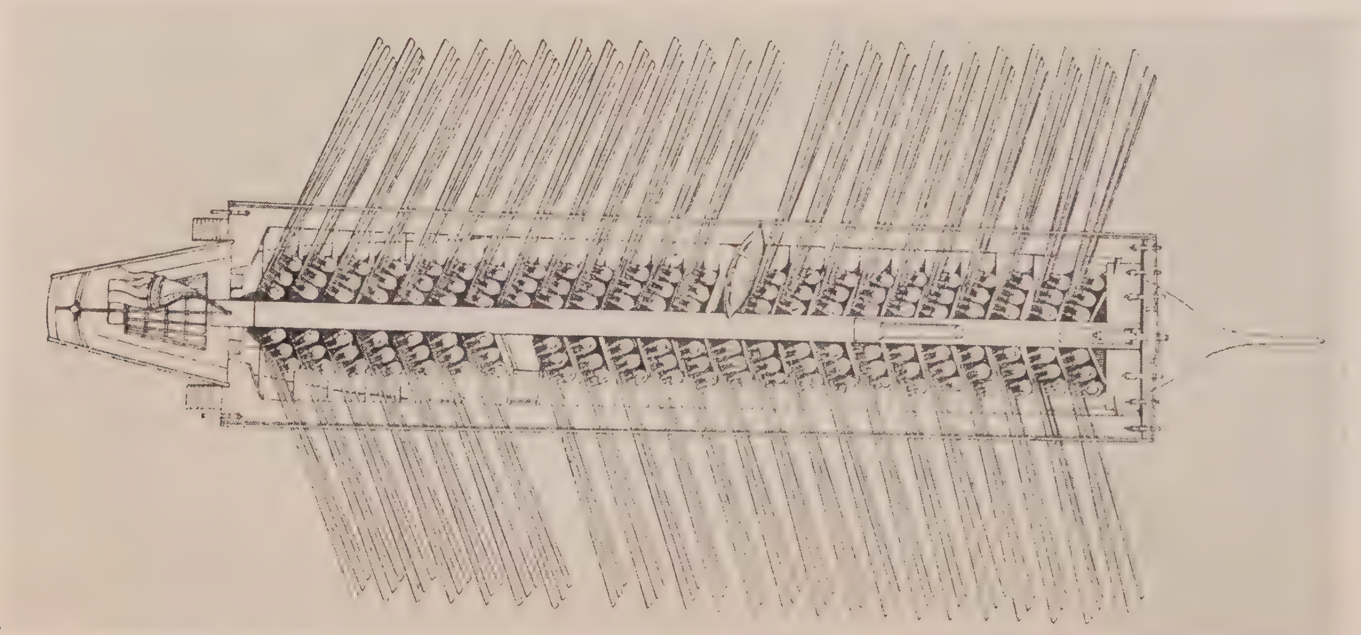
It would not be hard to believe that Greek and Roman ships rowed zenzile but no-one has reached a general conclusion. During the centuries oar-vessels did the fighting they must have reached perfection and a good way to learn what they were like would be to build trial row-ships and demonstrate which is best; too much depended on them and too many keen mechanics strove to improve them for us to believe otherwise.[7] The evidence tends to show that Greeks and Romans placed oars at several levels for some illustrations and all texts show this. The allusions of ancient writers to ships and rowing are numerous and translators draw the conclusion that oars were at several levels; this however cannot be the com-

[4] See p 33 v 1 Introd Cordier's Yule's M Polo regarding these 2 words whose origin Yule says he cannot explain. Pp 31–55 this Introd are of much interest regarding mediæval war-ships; illustr are given. Something as to zenzile and scaloccio rowing will be found in Jal's Glos Naut but it helps little to understand the origin of the terms.

[5] Fincati Le Triremi: a trans is in Serre's Mar de Guerre pp 154–208 v 1: pictures at pp preceding and following show rowing zenzile.

[6] P 162 v 1 Serre's Mar de Guerre: Fincati wrote in 1830.

[7] Builders were men of eminence: of late a statue to one who built 20-oar and 30-oar ships has been discovered in Cyprus; Jour Hell Studies v 9 p 255; Torr Anc Ships p 9.



A zenzile trireme shown in Fincati's Triremi at pp 325-71 Com e Mem 3d Internat Geog Congr Venice, 15-22 September, 1881, in v 2; also Raccolta di Doc e Studie Publ dalla Reale Com Columbiana (at 4th centenary) pt 4 v 1, being p 25 v 1; also pl 2 v 1 Serre's Mar de Guerre: oars at several levels are in pictures at p 34 above and scaloccio rowing—several men on one long oar below. As this vessel mounts guns she can hardly be before 1450 and by that date scaloccio had replaced zenzile rowing. The picture is modern and may be in error in this respect, but shows how ships pulled zenzile. This is seemingly a reconstruction made by Fincati.

plete solution for we have seen that a 16-bank ship so oared is an impossibility and Livy a reliable contemporary author refers to such a vessel as of size almost unmanageable.

SHIPS OF LARGER RATES; A DRY DOCK; LEAD PLATES ON SHIPS; LAUNCHING.

The ancients built ships rated above 16-banks. In a note just above 20-banks and 30-banks are alluded to and we are also told,[8] " Philopator built a ship with 40 ranks of rowers "; which ship the author continues was 420 feet long and used oars 57 feet long, supplied with lead weights at their handles so that, " Being accurately balanced they were very easy to use." A description of a dry-dock follows; from it, " The water is drained off again by means of engines." This all falls in the reign of Ptolemy Philopator in Egypt 222 to 205 B C. Athenæus calls this ship a *tessera-kontere;* the equivalent of 40-oar, as *triere* is of 3-oar. At about the same date an *eikosore* 20-oar was built at Syracuse in Sicily by King Hiero, her design being drawn by Archimedes: Athenæus says of her, " Every part as soon as completed was covered over with plates of lead. xx Archimedes launched her by himself; with the aid of a helix he drew her enormous as she was down into the sea." It was quite modern times when ships were always coppered but we have it here in part at least 200 years before the Christian era.

PLATES OF METAL ON SHIPS.

Admiral Serre gives Athenæus' words about plates thus,[9] " The seams of the eikosore xx were covered with plates of metal to prevent the caulking from coming out." Perhaps the lead plates covered only the seams and not the bottom entire for Portuguese and Spanish ships were thus covered about 1500, when it was found that in large ships on long voyages caulking worked out and the ships leaked fast.[1] Also a Roman ship built about 100 A D and covered with lead plates fastened by copper nails has been raised from the bottom of a lake where she lay 1400 years.[2] It may be added there is account of lead plates placed vertically on ships'

[8] Athenæus Deipnosophists trans Yonge Bohn v 1 pp 324–5: Athen lived 230 A D and says he had these accounts from earlier authors.

[9] Mar de Guerre v 2 p 187.

[1] Below pp 225, 350, 629. Drake's ship Pelican had 2 sheathings but no copper; she leaked not a little; p 611 below.

[2] Below p 225: it would appear the whole bottom of this ship was covered.

side above water to prevent penetration of projectiles, what we call side armor, in about 1550.[3]

TESSERAKONTERES AND EIKOSORES.

Admiral Serre alone has worked out ancient ships of all ratings and supplied descriptions and scale-drawings of them and has included vessels of these classes.[4] The former he makes of 2600 tons displacement arranging the oars in 3 horizontal lines 3200 oarsmen in all; 10 men, 5 facing aft and 5 forward, at the highest oars, taken at the length stated by Athenæus, 57 feet; 6 men at each middle oar; and 4 at the lowest. Thus there would be 40 men in a plane transverse to the ship and by this the Admiral justifies the name 40-oar. There is collateral proof of the wonders Athenæus writes of; Theocritus who lived in the day of these ships says of the Ptolemys, "Their ships are the best that sail over the sea."[5] A ship of these days had the first bilge-pump of which there is record,—in about 225 B C, and although she was large one man could pump her dry. It consisted of leather buckets strung on an endless rope driven by a winch; there was a well in the bilge to collect water and a discharge port above the water outside was fitted.[6]

A RETURN TO ARRANGEMENTS OF OARS.

There were 3 ways of manning oars; (1) placing men above and below each other, (2) all in one level,—each man in these 2 ways having his own oar; and (3) putting several men on each oar, the oars being in one horizontal line, Admiral Serre is of the view that the Greek and Roman texts show oars at different heights,[7] that the number of horizontal lines never exceeded 3, and that oars longer than 59 feet, with their tholes 7 feet from the water, are impossible. Perhaps the Admiral reasoned thus: an oar longer than about 59 feet cannot be used no matter how many men are on it; oars 59 feet long may have thole-pins 7 feet above the water; in a hull of 7 feet freeboard 3 men can be placed one above the other. He believed that up to the 3-oar triere different lines of oars were employed according

[3] Below p 465.

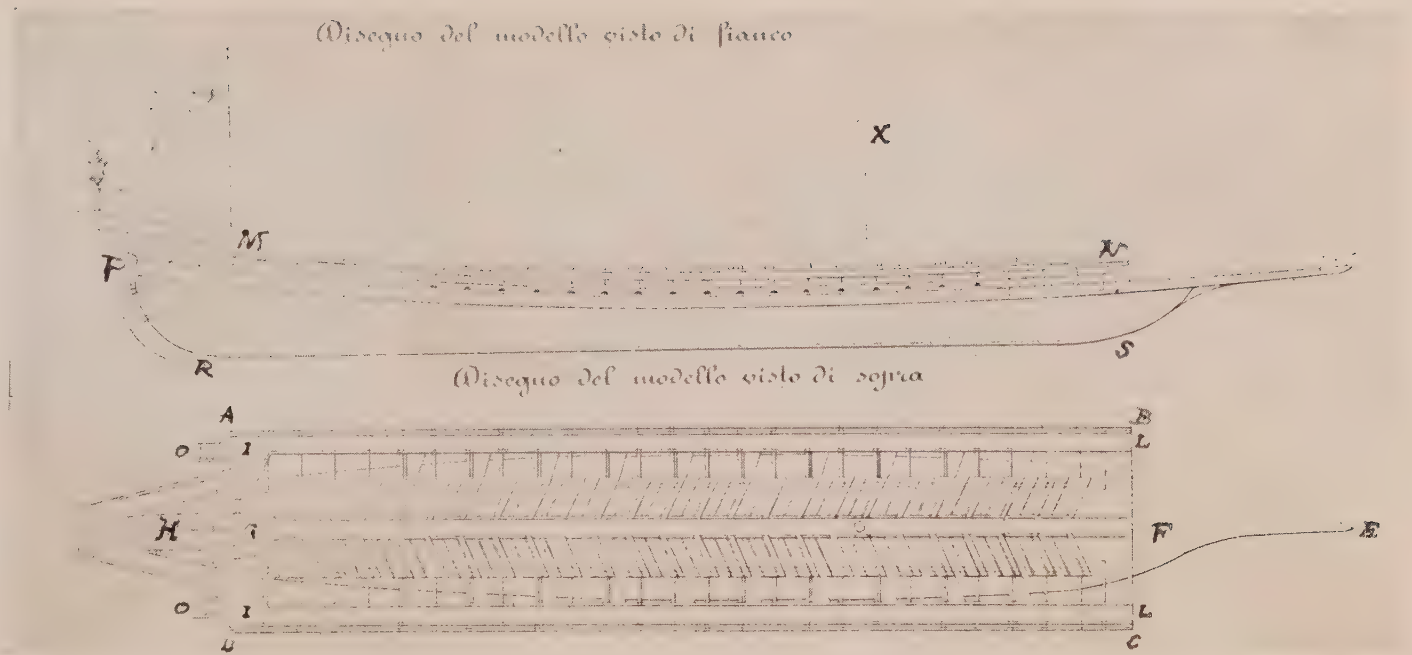
[4] Mar de Guerre v 1 pp 54, 61.

[5] Idylls Theocritus Bion Moschius and War Songs of Tyrtæus Bohn p 95.

[6] Cartault Triere Athennienne pp 45–46; below p 646 as to pumps in later days.

[7] It will surprise many to read Serre's Mar de Guerre v 2 p 74 that oar-ports at 2 levels, "May be seen in some of our fishing-vessels:" the Admiral wrote in 1880.

This is Battle of Salvore in 1176; from pl 133 v 3 Zanotto's Palazzo Ducale: it was painted by D Robusti called Tintoretto whose day was 1512-90. Salvore now Salboro is on the coast between Venice and Trieste, see Hazlitt's book cited legend picture p 84 below. The rowing is zenzile: see below for picture scaloccio rowing. See p 84 below for another picture of Battle of Salvore.



ELEVATION AND PLAN OF A ZENZILE TRIREME.

From Fincati's Triremi identified legend picture p 78 above. The dimensions are given below in English feet. PR, Timone, rudder. RS, Chiglia o columba, keel or hull. MN, Impavesata che difende e nasconde gli uomini, fights that defend and cover the men. X, Albero spezzato, mast broken off. ABCD, Telaro e ali della galea, Telaro or wings of the galley; the cross-pieces at ends were called *joug*, yoke, the two fore-and-aft pieces *aposti* or *posticci*. ABDC, Posticci su cui posano remi, Posticci (aposti) on which oars are shipped. AD, Giogo di poppa, Joug or yoke at stern. BC, Giogo di prora, yoke at bow. F, Palmetta di prora, H, Palmetta di poppa; spaces at bow and stern, where was a deck but no oars. GF, Corsia o strada da poppa a prora, Corsia, way from bow to stern. E, Sperone o rostra, spur or ram. ILIL, Balestriere o poste dei soldati, Balestriere or post of the soldiers. OIOI, Scaletti di accesso, little stairs to come aboard. Langhezza da ruota a ruota, length from stem to stern, 137. Larghezza, ⅛ della langhezza, width, ⅛ length, 17¼. Altezza, ⅓ della larghezza, height, ⅓ beam, 5¾. Distanza da un giogo all' altro, distance from one yoke to the other, length of rowing space, 116. Distanza da una posticco all' altro, distance from one posticco to the other, width from thole-pin to thole-pin, 25½. Banchi 25 per parte, remi 150, 3 per banco, benches 25 on a side, 150 oars, 3 to a bench. This is a reconstruction made by Fincati.

to the service in hand: when there was occasion for ceremony or a run at speed all 3 lines were manned, when a long run was to be made the lines rowed in turn while other oarsmen rested on their thwarts, and in each of these cases men pulled their own oar: in battle the Admiral thinks only the upper oars were used each with 3 men.[8] If they used the last plan ships had an agility impossible with more complicated plans, for they could row sternward strongly on one side or both by the men dipping under their own oar turning themselves about and re-seizing the oar or seizing the one which had been behind them. Ships could back one side and pull the other when it was desired to turn and though nowhere mentioned it must have been possible to guard one's own oars when brushing by or charging the enemy or coming near a friend. Several tiers of oars could not be trailed alongside nor brought within-board quickly which circumstance points to simple arrangements of oars in battle and use of trail-lines; yet of the last the only indication is shadowy.[9]

Ships of heavier rates than trieres, tetreres penteres up to the great tesserakontere, that is 4-oars, 5-oars, 40-oars, for these names and those of intermediate rates are found in the books, Admiral Serre thinks were too large to be rowed by a single line. These he calls *polyremes* and thinks they used more than one line at all times, losing thus the triere's agility her power to run backward and turn. It may then be Greek and Roman long-ships used oars at more than one height and we must limit the number to 3 because with this the tholes of upper oars are 7 feet from the water and upper oars 59 feet long. There is similar limitation in zenzile rowing: in this there were perhaps never more than 3 oars in one port, the port being wide and having 3 pins in it; to gain more power ships were arranged for one man on the outboard oar and 2 on each within it. This would require the 2 inboard oars to be long and make the rowing more complicated. There would be 5 men on each thwart on each side, 10 counting across the vessel, which means a vessel of 30 feet beam and more than 250 feet length. This was probably a maximum in this rowing.

THE APPURTENANCES OF OARS.

The fittings of oars were the same as now. A ring of hide or rope held them to the thole-pin; the Greeks called this *tropos* and it may have

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[8] Below p 84 for account of small craft passing under oars in battle; a thing impossible with lowest oars in play,—not more than 2½ ft above water.

[9] See picture at p 30.

included a line by which to trail the oars alongside though this is not found in the texts. We now call this ring a rowing grummet. The thole-pin the Greeks called *skalmos;* a piece of leather covering the oar-port with a round hole the size of the loom of the oar and a slit long enough to allow the blade of the oar to be thrust through they called *askoma.* This leather its hole being filled by the oar and the lips of the slit standing close together kept dashing water from entering the vessel. The thwarts were provided with cushions; *uperesion* the Greeks called these: they were necessary in all ways of rowing but particularly when the men rose at each stroke and threw themselves backward on the oars taking the water. Thucydides tells of men in ships at Corinth being sent on foot across the Isthmus of Corinth a distance of about 10 miles;[1] "The plan was that each rower should take with him his oar his cushion and his thong and go by land from Corinth to the sea over against Athens and proceeding with all speed to Megara should put off with 40 trieres which happened to lie at Nasæa their naval station and sail immediately for Piræus; for there was no naval force or guard therein there being no expectation the enemy would make so sudden an attack." This passage is sometimes referred to as proving Greek vessels used oars at more than one level and had the same number of oars and oarsmen. It proves the last but not the first for the rowing may have been zenzile. Our conception of the operation is added to by noting that as there were 200 oarsmen in a triere a number which lasted approximately from the earliest days and through mediæval times and 40 trieres the walking party consisted of 8000 men each carrying an oar a cushion and a rowing grummet;—other impedimenta as well no doubt though the kit of a Greek seaman was nearly all on his back.

EXAMINATION OF TEXTS AND PICTURES OF ROWING.

The evidence shows that scaloccio rowing long oars with several men on each came in about 1500 A D, and that in earlier time rowing was zenzile or else oars were at several heights. Admiral Fincati's view is that oars were zenzile in 1200 A D and long before and were so rigged until 1500 A D when scaloccio rowing was adopted. The allusions of Greek and Roman writers to rowing imply oars at more than one height in clear

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[1] Bloomfield trans 3 vs bk 2, 93. The vessels are trieres and the date about 400 B C; by Serre's figures the longest oars were 23 ft; Mar de Guerre v 1 p 34.

terms;[2] these if we accept the reconstructions of vessels of larger rates worked out by Admiral Serre offer no insurmountable difficulty. To take up now evidence at variance with Admiral Fincati's conclusion that ships rowed zenzile before 1200 A D and at that date. There are pictures of Phenician 2-oars of 700 B C of 3-oar Greek ships on the Acropolis of 400 B C and of 2-oars and 3-oars on Trajan's column of 115 A D.[3] There is also a picture of a *diere* or *bireme* in the Cantigas del Mar of Alfonso the Wise King of Castile 1250 A D showing oars in 2 horizontal rows.[a] It would seem impossible ships rowed one way at Venice and another in Spain: it has been impossible to learn the history of the figures in the Cantigas for the work remained in manuscript for many years and there is no way to prove the authenticity of the drawings. There is a text a century earlier than the Cantigas confirming these pictures and irreconcilable with zenzile rowing in 1200: Geoffrey de Vinsauf who accompanied Richard of England to the Holy Land in 1189 writes of the galleys of the crusading fleet,[4] " With the ancients xx some plied the oars at a longer and others at a shorter distance from the sea. These vessels had frequently 3 or 4 banks of oars each some even 5 xx. But all that ancient magnificence has passed away for ships-of-war that once had 6 banks of oars have now seldom more than 2." The expression oars at a longer

[2] Only by finding an ancient vessel could doubt be dispelled. There seems chance of this: at and near Lade off Miletus not less than 2000 long-ships of Greek days fought and many were stove. Here the Persian fleet fought the Greeks in 496 B C; near by in 479 the Battle of Mycale was fought; in 333 the fleet of Alexander the Great met the Persian fleet here; in 201 Macedonian and Rhodian fleets fought here: Polybius tells regarding this of (bk 16, ch 15), "The original despatch of the admiral concerning the battle sent to the Senate." A map opp the title page in v 4 Rawlinson's Herodotus shows the locality of Lade; and note p 416 v 3 states on modern authority that the topography of the locality has changed; that, "The whole scene of the sea-fight of Lade is now land." See also pp 282–3 v 1 same work for other maps of the locality and Brit Adm chart 1546, where the Island of Lade appears as part of the main-land being a hill 300 feet high. A hull might be found near Mount Athos where Xerxes lost many ships or at the entrance of the Bay of Actium where were several combats.

[3] Above p 33.

[a] Serre Mar de Guerre p 90 v 1 for this: there is also a picture of this vessel in Antigua Marina Catalana Bofarull y Sans in Real Academia de Buenas Letras Nov 1898; no 6 is a vessel of 13th century from the Codice del Escorial Las Cantigas del Mar and no 7 a galley of the same century: the first has sails, is a *nave*, and the second is like the vessel shown by Serre except it has a mast stepped which the vessel in Serre is without.

[4] See p 406 below.

and others at a shorter distance from the sea can be interpreted in one way only.

THE OLD TEXTS.

We now come to Greek and Latin texts: in a play of Aristophanes a player recounts he,[5] " Breaks wind into the mouth of a thalamite." The *thalamite* were the oarsmen nearest the water and in storied oars the men were somewhat in front of as well as above those next below them. Aristophanes lived during the Peloponnesian War and his plays were given before audiences of seamen. Arrian says the ships of Alexander the Great when coming down the Indus in 325 B C were injured by eddies in the river,[6] " Especially the biremes whose lower bank of oars was but little above the surface of the water for they xx could not lift up their oars." There is little in Herodotus or Thucydides about how oars were arranged. Ships of different rates are mentioned and Thucydides tells how in Syracuse harbor in 413 B C Syracusan small craft passed with hostile purpose,[7] " Under the oars of the Athenian trieres." Polybius whose date is 150 B C tells of a battle in 201 at which,[8] " A 10-banked ship which xx was the admiral's was captured in an extraordinary manner. For a light vessel having run close under her struck against her violently amidships just beneath the thole of the topmost bank of oars where she was fast jammed xx. While in this plight 2 5-bank ships charged her on both sides at once." In Appian occurs a similar expression,[9] " Vessels gliding along under the banks of the great Roman galleys." Admiral Serre cites these passages to prove ships did not use their lower oars in battle; though to provide short and light oars to be used when making long passages these were fitted. Their tholes were little more than 2 feet above water.

THE WAR-SHIPS OF LEO THE WISE 900 A D HAD OARS IN DIFFERENT LEVELS.

There is this description of oars in several levels in the book of Leo the Wise East Roman Emperor 886 to 911 A D;[4] " Each dromon should

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[5] Bohn v 2 p 588; Cartault Triere Athen p 133; Serre Mar de Guerre v 2 p 63: notwithstanding the clearness of the expression the meaning has been disputed.

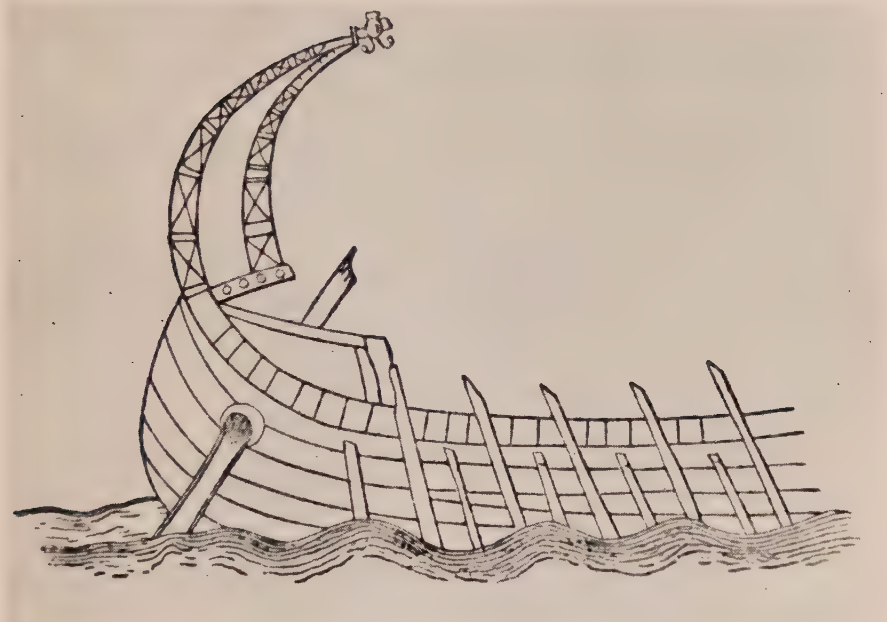
[6] Exp Alexander trans Rooke 2d ed p 154.

[7] Serre Mar de Guerre v 1 p 32: the passage is bk 7, 40 Thuc and has been otherwise translated.

[8] Bk 16, 3 and 4: see Serre v 1 pp 119–134 for comment.

[9] Eng by J D 2d ed p 54: the date of the battle is 146 B C.

[4] Inst Mil Leon le Philosophe trad Maizeroi 2 vs v 2 pp 137, 162. *Dromons* were war-ships.



Dromon. (*Códice de las Cántigas del Mar.*)

See note a p 83.

Battle of Salvore shown also in picture p 80: this one is from p 35 Cordier's Yule's M Polo, Intro, and originally from a fresco at Siena done by Spinello Aretini, 1334–1400. Both this artist and Tintoretto show the rowing correctly though in the day of the last it was scaloccio. Hazlitt's Venetian Republic pp 223–25 v 1 states the custom of Venice wedding the sea on Ascension Day was begun 1177, the year after this battle. Note that not only 2 oars are shown on each thwart but the 2 oarsmen as well.

be xx with 2 ranks of oars one above the other below. For each rank there should be at least 25 seats to seat the rowers namely 25 below and 25 above and on each one there should be 2 rowers one to the right and the other to the left, which makes in all 100 men xx. Larger dromons containing as many as 200 men may be built. Fifty will be for the lower seats and 150 for the higher seats who are all armed for fight. xx You will choose robust and willing men, above all those who are for the party above who may fight the enemy. If there are weak ones of little value leave them below. From them you will also draw to replace those wounded above." Lucan a Roman of 60 A D writes of war operations before Marseilles in 50 B C,[5] "Liburnian barks content to increase with 2 ranks of rowers xx. But the admiral-ship of Brutus more lofty than all is impelled by 6 tiers of oars and carries a tower along the deep seeking the sea from afar with its highest oars." It is difficult to see how this can mean anything but oars at several levels: the tholes of the topmost of 6 tiers would be 12 to 14 feet above the water and the oars about 100 feet long. These dimensions depend on the vertical distance necessary between 2 lines of men.

MEDIÆVAL AND MODERN ROW-SHIPS IN REGIONS WIDELY SEPARATED WHICH EMPLOYED MORE THAN ONE LINE OF OARS.

A modern writer Montelius says,[6] "Erling Skacke in Norway caused a boat to be built with 2 banks of oars one over the other": in another modern work we read,[7] "In 1206 Erling Steinvaeg xx built 3 ships xx. These had what neither before nor since has been known in Norway 2 tiers of holes for oars; the oars of the upper tier were 30¾ feet long." Pigafetta says when he reached the Molucca Islands with Magellan in 1520 he saw a, "Prau with 3 tiers of rowers on each side: in all there were 120 rowers;"[a] and there is testimony of officers of the French navy that vessels rowed by more than one line of oars existed 200 years later in this region: Admiral Paris writes, "The Malays produced a true trireme" and gives a cut of the vessel.[8] The cut is small and comes from better pictures showing side and end-on views in the Voyage Autour du Monde of Pagès,

[5] Pharsalia Riley prose trans Bohn p 115 (bk 3).
[6] Civiliz Sweden Anc Times p 182.
[7] Below p 401.
[a] Robertson's Magellan v 2 p 101.
[8] Musée Mar du Louvre p 11.

Capt des Vaisseaux du Roi.[9] Captain Pagès calls the vessel, " Bouanga a kind of pirogue having 3 ranks of oars;" and his description of how the oarsmen sit is clear: " It is difficult to believe the speed of these craft;" he writes,[1] "it is possible to place 150 oarsmen onboard and 40 paddlers xx. The Mahometan Indians use these vessels to cruise against and capture Spanish Indians. They sell their captives in Borneo and sometimes Batavia where I have seen with surprise slaves who must have been the free subjects of the King of Spain." Pagès goes on to explain how these vessels fight: beginning by throwing missiles for they rarely had fire-arms they board sword in hand. In and near the Philippines the innumerable islands supply lees against wind and wave which may be used as stopping places and thus voyaging there is like that in the Greek archipelago and Mediterranean generally; and that craft of similar description should grow up in the two must go far to carry conviction that row-vessels used oars in several heights. There can be no doubt we have here 3-oar vessels and a glance at the picture shows how the oarsmen were placed. It seems that Anson and La Perouse notice these vessels but I have been unable to find the reference. Admiral Serre missed the bouanga in some way for he does not allude to her. The vessels with which William the Conqueror invaded England in 1066 seem to have used oars at 2 levels for illustrations of them in the Bayeux Tapestries show oar-ports below the gunwale.[2]

LIBURNIAN GALLEYS.

These have just been alluded to in a battle off Marseilles in 50 B C and while their story is not clear they are too important to be passed over. They derived their name from Liburnia a region at the head of the Adriatic Sea where first constructed. They are mentioned by Cæsar in 48 B C; and Eutropius who died 370 A D says there were Liburnian galleys at

[9] Ed 1782 2 vs; plates 8 and 9. Pagès published another book of travels: the last has been translated into English but the ed including the plates seems rare. The Hispanic Society Library in New York has a copy.

[1] V 1 pp 169–174. See picture of this vessel p 76 above.

[2] Bay Tapestries Fowke: many ships are shown; all very out of scale; some have horses in them; grounded ships are balanced by men on both sides with long poles; some have hawsers to trees onshore; all have one mast with one yard at the head of this and sail coming to a point at its foot; men are wading between shore and ships with trousers off and coats on. See below p 266 for description of what may be a compass in these ships.

Mylæ 260 B C.[3] Neither author says how they were fitted but Horace whose date is 100 years later than Cæsar's writes,[4] "Thou wilt go with Liburnian galleys among the towering forts of ships;" which agrees with Lucan quoted just above in showing Liburnian galleys were low. Admiral Serre's conclusion is as follows; [5] "We must conclude that the Liburnian trireme like the Venetian trireme was a polyreme having 3 rowers on each seat with thole-pins at the same height; xx which arrangement does not permit as did the arrangement in the Greek 3-oars the reversal of the oarsmen to row backwards." That is Liburnian and Venetian triremes rowed zenzile: Admiral Serre must mean Venetian triremes of 1200, not of 1500, which last placed their oars scaloccio-fashion. The view that 3-oar vessels could reverse their pulling cannot be extended to them when pulling 3 horizontal lines of oars; the Admiral expresses belief they did this only on occasions of parade and ceremony, when each man handled his own oar; in battle he thinks they employed only the upper tier of oars each with 3 men on it. When rowing the latter way the crew could reverse themselves and pull the vessel backward but not when rowing either 3 horizontal tiers at 3 heights or zenzile-fashion. Thus Admiral Serre believes the Liburnian galley which appears about 50 B C and of which many were present at the Battle of Actium in 31 B C rowed zenzile. It cannot be that this appeared suddenly, that it was unknown in the seafaring world before 50 B C. It may be Admiral Fincati is correct; that Greek ships rowed zenzile in the way Venetian ships rowed in 1200 A D but the evidence for oars at several heights is copious.

BACKING WATER.

If war-ships were agile; if they cut the enemy's line and quickly turning rammed astern, or passing close swept off his oars as we are told they did do, it is hard to believe their rowing was either zenzile or with oars in several horizontal lines. The former manœuvre requires quick turning for which it is best to row backwards on one side. Ways of reversing quickly and rowing backwards strong are described above and also caring for oars when passing near another vessel. There must have been some way of disposing the oars not described in the books. Ancient authors use words

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3 Com Civil War bk 3, 5; p 318 Bell ed 1908: Justin Nepos and Eutropius Bohn p 465. The last writes of a period 600 years before his own.

4 Smart ed Bohn epodes ode 1.

5 Mar de Guerre v 1 p 83; v 2 pp 219, 234–5.

implying oarsmen changed seats or places and changed or turned the oars: these are the Greek words *metakathezomai* and *krouesthai ton prumnan* and Latin *mutato remigio.*[6] Nothing can be clearer than that if ships passed each other close and turned about quickly they were rowed by one line of oars though each oar may have been pulled by several men.

WHAT THE HISTORY OF WARS TELLS.

A very striking thing is the tone of finish with which the earliest authors write of war on the sea. It had been long talked of and perhaps written of when Herodotus and Thucydides wrote for there are no doubts and principles are expressed as in histories emanating from modern general staffs. Even Homer is clear; for Thucydides quotes him as to the Trojan War 1200 B C,[7] " All were rowers and fighting men as he has shown us xx for he represents all the men at the oars as bowmen. xx They had not their vessels decked but equipped after the old fashion more like pirates." Thucydides says of a battle off Alalia on the east coast of Corsica in 535 B C,[8] " Though many generations after the Trojan War they appear to have used but few trieres and to have been still fitted out with penteconters as that fleet was. Themistocles persuaded the Athenians when at war with the Æginetans[9] and when the Persians also were expected to build those very ships with which they fought them by sea and these were not yet decked throughout." Herodotus gives interesting details of Alalia, fought by allied Etruscan and Carthaginian ships to keep Greek Phoceans from establishing themselves near them; he writes,[1] " The Phoceans were victorious but xx they lost 40 ships in the battle and the 20 which remained came out of the engagement with beaks so bent and blunted as to be no longer serviceable. The Phoceans therefore sailed back to Alalia and taking their wives and children onboard with such portions of their good

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6 Serre Mar de Guerre v 2 p 46. The words are in Greek and Latin dictionaries and clearly show oarsmen faced about. See above pp 30 as to trail-lines and 518–19 below as to backing.

7 Bk 1, 10.

8 Bk 1, 13–14. It is meant ships were like those of the Trojan War *penteconters;* 50-oar ships, 25 on each side in one line. In Homer (p 313 Lang Leaf and Myers trans of Iliad 1883) is given one of the very few dimensions we have of ancient ships, " The oarsmen's bench of 7 feet long." This would give room though scant for 2 men on each oar 4 on a complete thwart. The vessel would be 9 or 10 feet beam and 75 feet long.

9 In 500 B C; preceding the first coming of the Persians, 496.

1 Bk 1, 166.

and chattels as the vessels could bear bade adieu to Corsica." This is the oldest *written* description of a battle with rams, 535 B C, and it is manifest that ramming was familiar.

Thucydides says that in 500 B C Themistocles persuaded the Athenians to build trieres that these were not decked and were the craft that fought at Salamis in 480 B C. Very shortly after 480 trieres had decks for they had them in the Peloponnesian War which began 431. It was *beneath* the rowers, its edges coming to the side a short distance above the water-line, and was adopted to make the ship strong in ramming and provide a dry place for stores. The fact that its edge was a few inches only above the water-line should not be overlooked for it shows how little extra flotation row-ships had; how they became water-logged on taking over the rail a little water. Thus the principal deck of Greek ships was put in in 500–450 B C: as to another deck we have record that Cimon who commanded the Greek fleet at the Battle of the Eurymedon in 450 B C sailed from Triopium the south-west corner of Asia Minor, " With a fleet of 200 ships which Themistocles had in their first construction made light and fit to turn with the utmost agility. Cimon widened them and joined a platform to the deck of each so that there might be room for a greater number of combatants."[2] This is the *catastroma* deck: it was above all oarsmen; on it men with swords and javelins and wearing armor and unarmored bowmen and stone and javelin throwers were stationed in battle. It also protected the rowers from missiles. The rowers were between 2 decks, the main deck below and catastroma above: it is unlikely lines of oarsmen were ever separated by decks for it would prevent their seeing each other and increase the difficulty of rowing. It is not clear what is meant by Cimon widening ships; he could not widen the hulls: perhaps he built on them what was called a *telaro* in mediæval days; a rectangular frame larger than the outline of the ship on the water, like a picture frame. This was set on ships, giving out-rigged tholes for oars and making oars of one length.[3] Telaros were used by mediæval galleys where rowing was zenzile or scaloccio; they could not be used with oars at several heights.

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[2] Plutarch Langhorne trans Cimon v 3 p 183.

[3] Arch Navale Jal v 1 p 289; v 2 p 49: also his Gloss Nautique, word *telaro*. See below p 291 n 3; also picture p 79 above.

THE WINGED VICTORY OF SAMOTHRACE.[4]

This monument of a ship is in the Louvre in Paris and a full-size reproduction in the Metropolitan Museum in New York. It consists of a winged figure of a woman on a pedestal formed like a war-ship and was found in the island of Samothrace 40 miles N W of the entrance to the Hellespont. Judges believe it was made to commemorate victories of Demetrius surnamed Poliorcetes or Taker of Cities in whose fleet in 306 B C standing throwing-machines mounted in ships were fired against ships for the first time.[5] A view of the monument without the winged figure is at the end of Cartault's Triere Athennienne; Serre gives this [6] examines the dimensions of the craft forming the pedestal and supplies scale drawing of its cross-section. There is nothing to show what rate of ship the artist had in mind and perhaps because in the day of Demetrius ships were large Admiral Serre seems to conclude she was an *octere* or *decere*, 8-oar or 10-oar, for his drawing shows a ship of that rate; whence it would follow the scale of the pedestal is $^1/_5$ to $1/4$ natural size.[7] The draft of the Admiral's cross-section is 5 feet; depth from catastroma deck to the bottom 20 feet; width across from thole to thole 23 feet; [8] longest oar 33 feet with thole 5 feet above the water. The catastroma is 15 feet above water, 20 above the bottom or the ground when the vessel is brought to it; a man climbing onboard would be in 5 feet of water, and the upper deck 15 feet above his head.

The Winged Victory is important in the history of long-ships; if we take the pedestal to be a decere or octere $1/4$ to $^1/_5$ natural size we may derive from its dimensions those of vessels of other rates: those of trieres for example would be less by $1/2$ to $^1/_3$. Their upper or catastroma deck would be 13 feet above the bottom; by this amount would this deck be above the feet of a man standing in the water near the vessel when grounded. So a man could not climb to that deck unaided; but as the height of the oar-space was about $1/2$ the above an active man could climb

4 Called also *Nike;* Greek for Victory in Battle.

5 Below p 99.

6 Mar de Guerre v 1 pp 50–53.

7 Following are measurements of the reproduction in the Met Museum: from vessel's bottom to catastroma deck, 6 ft 3 in; greatest dimension across beam, 8 ft; beam across catastroma deck, 6 ft; beam at ship's bottom, flat and without keel, 3 ft, 7 in. Most of the vessel's height is 6 ft wide; the greatest beam 8 ft, which is across where tholes of oars are: the reproduction is roughly a square with 6 ft sides; if of a decere or octere the cross-section of these was roughly a square 24 to 30 feet.

8 Space for 8 or 9 men; 4 a side.

ERNEST THORIN, éditeur

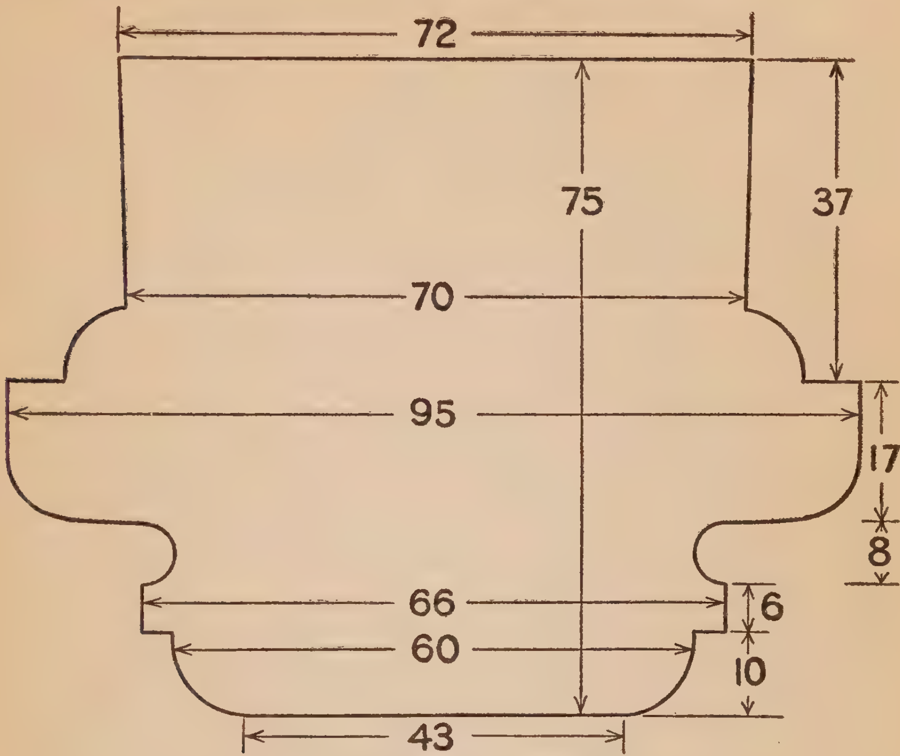
E. S. p...

A. Quantin, imp.

PIEDESTAL DE LA NIKE DE SAMOTHRACE REPRESENTANT UN AVANT DE NAVIRE.

The figure of the Winged Victory is here omitted.

onboard there. The figure here is the outline of the Victory and its dimensions in inches are given: multiplying these by 4 or 5 gives the octere or decere of 306 B C.



RATINGS OF WAR-SHIPS.

There is little about ratings in Herodotus or Thucydides; both mention penteconters and trieres and say little of what these were like and do not name other classes. Trieres were the battle-ships by 500 B C having displaced penteconters: their first employment lies further back for Thucydides says,[9] "And now Greece began to construct navies and to apply more assiduously to nautical affairs. The first who introduced a change in the structure of vessels so as to form them very nearly in the present mode are said to have been the Corinthians and trieres are thought to have been built first of Greece at Corinth. It appears too that Aminocles a Corinthian ship-builder also constructed such vessels for the Samians. Now it is about 300 years from the time when Aminocles went

[9] Bk 1, 13 Bloomfield trans.

to the Samians to the end of this war, and the most ancient sea-fight within our knowledge is that of the Corinthians and Corcyreans. Now from the time the engagement occurred up to the above-mentioned period there are about 260 years." That is trieres were built first in Greece 700 B C and the first sea-battle Thucydides knew of was in 664. The date of the dieres 2-oars of Phenicia on Assyrian monuments is 700 B C [1] and before this Egyptian ships which had been the principal carriers in the Mediterranean disappear from the records to reappear after Alexander the Great conquered the country and the Ptolemys became its sovereigns. Greece and Phenicia were perhaps struggling for control and drove Egyptian ships from the sea.

THE EFFECT ON SHIP-CONSTRUCTION OF STANDING THROWING-MACHINES.

War-ships grew larger and in days shortly after the Peloponnesian War this was increased by introduction of throwing-machines whose discharge caused violent reaction on decks and sides. In the Punic Wars,[2] beginning 264 B C and lasting with short intermissions 118 years, the ship-of-the-line was called *quinquereme* by the Romans and *pentere* by the Greeks; 5-oar.[3] She was larger and heavier than the triere and carried more men. Polybius our most reliable authority as to the Punic Wars has much to say regarding these vessels.[4]

SAILS OF LONG-SHIPS.

As to sails Cartault writes,[5] "The triere had seemingly xx 3 masts a great mast and 2 others. The great mast was in the center of the vessel; xx it had at least 2 yards xx. The great mast had then at least 2 square sails." The size of the sails is not stated nor the gear by which they were set and taken in; but other evidence proves that this was the same as we use; clew-lines bunt-lines leech-lines bow-lines and yards had braces. The 2 smaller masts had fore-and-aft sails, so the ship could sail close to the wind though as the draft was little to make them easy to row,[6] they could not carry sail hard on the wind. All their weights were high;

[1] Above p 33.

[2] Below pp 150 and foll'g.

[3] Serre has plans and specifications of this as well as of tetrere, 4-oar, and *octere, decere,* 8-oar, 10-oar, etc.

[4] Below pp 151, 160 n 7, 179.

[5] See p 359 below.

[6] The draft of the triere was about 3½ ft; Serre v 1 pl 1. If the section is correctly shown in the Winged Victory they were not weatherly.

the rowers were above the water-line and above these was the catastroma deck some 5 feet above water. The center of gravity of the fighting-men stationed on this, even when seated, could not have been less than 9 or 10 feet above water; such disposition of weights and a draft of 3½ feet shows they were crank. Polybius who wrote about 150 B C shows how familiar sailing on a wind was to him; he says,[7] " Each nation being checked by the others no one part can turn the scale decisively but xx being in exact equilibrium the whole might long remain steady like a ship sailing close by the wind." Sailing on a wind and tacking were practiced 500 years and probably much more before Polybius' day.[8] The sails used by long-ships were both fore-and-aft and square the last being employed when the wind was free: fore-and-aft sails often called lateen were set with the sail on the lee side of the mast: see p 500 below as to the inconvenience of shifting lateen-yards from one side of the mast to the other.

SPEED.

There are statements regarding speed in Herodotus which refer to running under sail. In one place he deduces the length of the Black Sea from the assumption that,[x] " In a long day a vessel generally accomplishes about 70000 fathoms in a night 60000"; the first is 70 miles and the second 60 so the ship makes 130 miles in a day: he continues, " Now from the mouth of the Pontus to the River Phasis which is the extreme length of this sea is a voyage of 9 days and 8 nights which makes the distance 1110000 fathoms or 11100 furlongs." He makes the length 1110 miles, the correct figure being 700. Exactly how it was determined that a ship runs 70 miles in a day and 60 in a night there is not means to determine. It is not likely however that there is error in believing ships would make the run in 8½ days: this divided into the correct distance is $82^1/_3$ miles; this is about what Herodotus gives as an average run for several days—not a ship's best performance with a smooth sea and strong wind a little abaft her beam. A figure differing from this will be found in another place in Herodotus,[y] " The barbarians set sail with all their ships from Therma. xx A day's voyage without a stop brought them to Sepias in Magnesia." The distance is 103 miles.

7 Shuckburgh trans 2 vs bk 6, 10.

8 Below p 220. See Pliny, Bohn in 6 vs v 4 p 129 for passage showing yards of ships were so long as to project beyond ships' beam and referring to, " Sails upon sails," etc: this was written about 70 A D.

x Bk 4, 86.

y Bk 7, 183: this occurred a little before Salamis: by barbarians is meant Persians.

As to the speed of trieres under oars alone Admiral Serre believes they could row a short distance at 10 knots.[9] There are 2 passages in Thucydides which give an idea of speed with oars but data required is wanting and they help little. The first is in regard to a triere sent from Athens to Mitylene to countermand an order previously sent to put the inhabitants of that city to the sword. The distance is 220 miles, we know only that it was a continuous passage at highest speed: Thucydides says, "Some slept while others rowed."[1] From this it would appear probable each rower was on a separate thwart as with storied oars. With zenzile and scaloccio rowing men could rest only by laying-off all oars in part of the ship. The second case mentioned by Thucydides is a vessel sent from Pylos to Athens and return to negotiate a treaty. The distance out and back is 500 miles and she was back 20 days after starting. Allowing a stop of 7 days at Athens in regard to the treaty she made good 40 miles each of 13 days running. She probably landed her people to sleep and once more for a meal each day for this was always done. It seems a fair conclusion she may usually have been running 5 or 6 knots, and that part of the passage was under sail. We know nothing as to this and the case is mentioned only to show ships made reasonable despatch even when not greatly urged.[2] There is this passage in Polybius about speed which may be with either oars or sails;[3] "xx a 100 miles, a distance of a day's sail." When Xenophon returned from Persia to Greece in 400 B C with 10000 Greeks he brought them by ship from the east end of the Black Sea. In his Anabasis when nearing the mouth of the Bosphorus he writes, "It is a long day's voyage for a long-ship using her 3 banks of oars from Byzantium to Heraclea; and between these 2 there is not a single Greek or friendly city but only these Bithynian Thracians who have a bad reputation for the savagery with which they treat any Greeks cast ashore by ship-wreck or otherwise thrown into their power."[4] Byzantium and Heraclea are 120

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[9] Mar de Guerre v 2 p 109. See below p 245 n 1 for passage of a row-ship in modern days.

[1] Bk 3, 3.

[2] Thuc bk 4, 39.

[3] Bk 4, 41.

[4] Xenophon Dakyns trans Anabasis v 1 p 258. It was necessary to make one run here. P 235 this v is an interesting couplet; the ships are steering west in the Black Sea and Xenophon says to his soldiers, "Doubtless you know this too that it is boreas the north wind who bears the mariner out of Pontus toward Hellas xx, whence the saying,

When the north wind doth blow
Home to Hellas we will go."

P 247 he states long-ships, "In a day and a night with a fair breeze," ran from Cotyora to Sinope: the distance is 200 miles, $8^1/_3$ miles per hour under sail, a speed readily attainable.

miles apart and if we assume 26 hours for the long day the speed is $4^2/_3$ knots per hour. Few will believe that oarsmen whether the oars were storied or zenzile could pull at this speed for 26 hours. If by day Xenophon means daylight which is possible for row-ships seldom rowed at night, the statement seems incredible; for a summer's daylight in the Black Sea is 18 hours which results in a speed of 11 knots per hour.[5] The run could be made under sail with a fine breeze; but under sail alone for it was impossible to row when the ship was running at speed.

THROWING-MACHINES.

The people of Malaysia use a blow-gun as long as a man with a poisoned arrow a foot long to the rear of which is attached a piece of pith for an air-piston, place a front-sight at the muzzle, and can bring down birds at 50 yards. With a thrown boomerang birds and small mammals can be knocked over at 200 yards.[6] A very old way of throwing is the man-carried bow and the most generally used as well.[7] Throwing-machines of standing variety are also very old. These can be moved only with difficulty by unaided man-power and are in the class we call *guns of position* in which class are guns in ships and fortifications. They were in ships by 400 B C though we have evidence of their existence much earlier. Their effect on ship-design was marked, as it is clear ships were larger and more heavily built after 400. Large standing throwing-machines when fired would shake to pieces a Greek triere as constructed at the time of Salamis. Also cover against projectiles had to be provided adding to the weight or displacement of ships. Thus ships after 400 B C when we have record of standing throwing-machines going into them became larger and heavier in the manner ships of our day have grown larger to withstand the recoil-pull of guns becoming ever larger and carry armor to keep out shells.

Standing throwing-machines are represented on the stones[8] of

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[5] Pp 519–21 as to speed of row-vessels.

[6] Ratzel Hist Mankind Eng trans v 1 pp 415, 355. To use our phraseology such blow-guns are very "high-power," length is many times the diameter of bore. The lungs of the blower must have capacity to keep pressure on the arrow until it issues from the gun and we cannot doubt that in the years blow-guns have been used the length of travel of the projectile in the gun came to be closely proportioned to lung-power.

[7] See map p 145 v 1 work cited note next preceding showing limits in Oceanica of use of bow and arrow.

[8] Mon Nineveh Layard pl 29: see picture here inserted. From p 39 Morgan Anc Society it results man-carried bows and arrows were developed 40000 years ago: in Genesis ch 21, 16 and 20 we read Hagar when her child Ishmael was in danger, "Cast the child under one of the shrubs xx and sat her down over against him a good way off as it were a bowshot"; and Ishmael, "Became an archer:" the date is about 2000 B C.

Nineveh of date 700 B C and are referred to as follows in Second Chronicles;[9] " And Uzziah prepared xx slings to cast stones. And he made in Jerusalem engines invented by cunning men to be on the towers and the bulwarks to shoot arrows and great stones withal:" Uzziah was King 800 B C.

THERE WERE TWO MAIN CLASSES OF THROWING-MACHINES.

The engines shown on monuments at Nineveh and some of those mentioned in Chronicles were beams swung by a weight released having at their moving end a sling in which a stone or similar projectile was placed. When the beam's greatest velocity was reached one end of the sling slipped off its hook, by which impetus was added to the projectile. Many throwing-machines used in Greece and elsewhere were of another variety; large cross-bows mounted on a suitable base and bent by a winch. These projected missiles at low angles and high velocities while swinging-beams projected at high angles and low velocities. The engines Uzziah built to shoot arrows were cross-bows while those for stones were probably swinging-beams: arrows would go end over end if thrown by the latter. Thus we have record of both direct and high-angle fire in 800 B C; but not in ships.

ACCURACY OF FIRE.

There are 2 references to accuracy of fire in the Bible: in Judges 20, 16; " Among all these people there were 700 chosen men left-handed every one could sling stones at a hair-breadth and not miss;" the date is 1400 B C; in First Chronicles 12, 2, " They were armed with bows and could use both the right hand and the left in hurling stones and shooting arrows out of a bow;" the date is 1200 B C. In both cases a battle on land is being described. No doubt the stones were round and somewhat irregular in form; later we read of lead forms of regular size used in slings.[1]

HEAVY WEIGHTS DROPPED.

Ships were prepared to drop weights, *dolphins* they are called because formed like that fish, on the enemy's decks and rowers. In Aristophanes we read,[2] " But be on your guard and ere he comes up to you do you first

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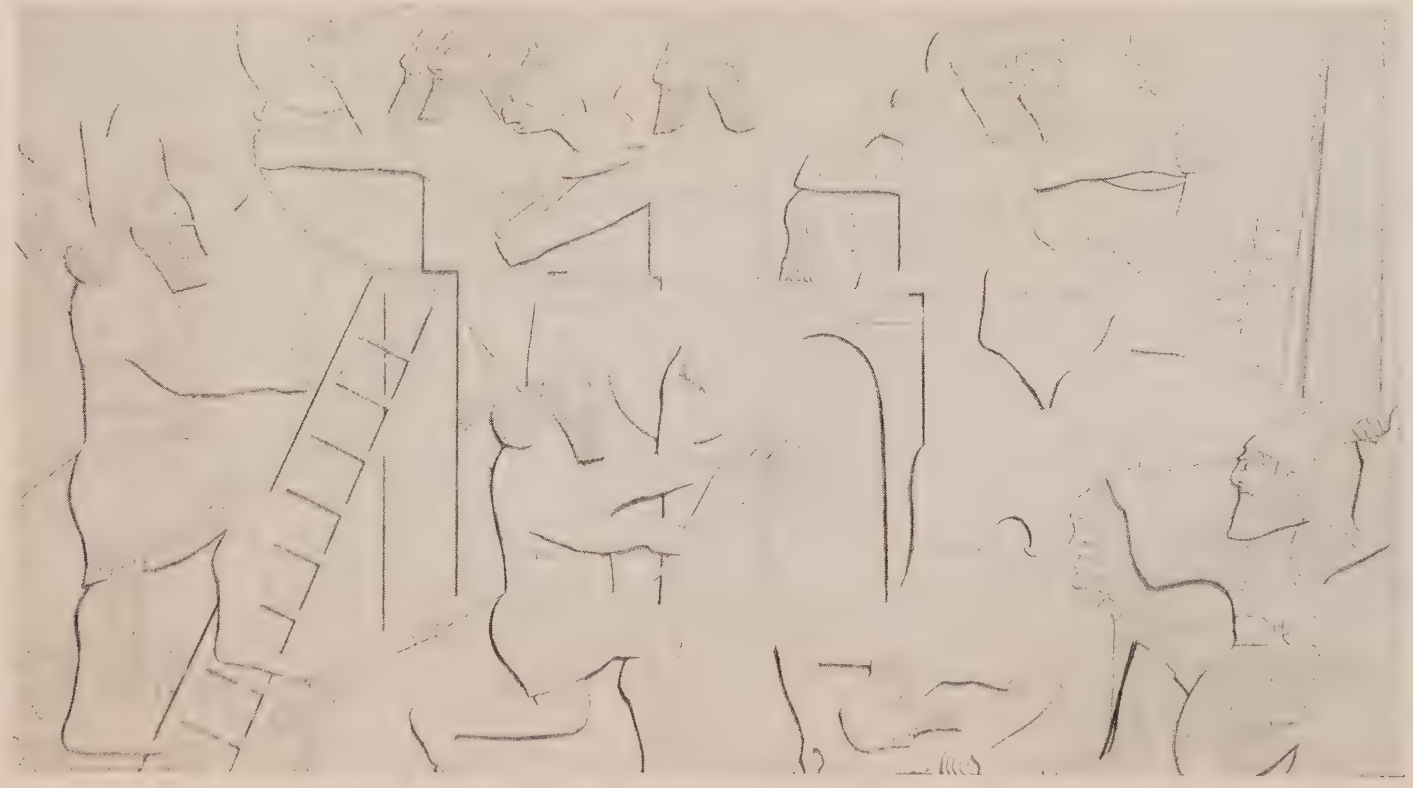
[9] Ch 26, 14–15. As to sieges see Deuteronomy 20, 19–20; Judges 20, 16; Ezekiel 21, 22. In later day we are told of the Balearic Islands, " A child receives no food from his mother but what he has struck down with his sling at her bidding;" Rom Hist Florus bk 3, 8.

[1] Appian of Alex trans J D p 135. Appian lived 100 A D and is writing of events in 80 B C. See again below p 102 as to accuracy of fire.

[2] Knights line 760, p 86 v 1 Bohn.



This is from pl 29 Layard's Mon of Nineveh. Layard states belief the vertical poles at the right are swinging-beam throwing-machines: (partly because the apparatus with 4 tongues held near the poles is fire.) Fire is elsewhere shown in the picture. Its date is 700 B. C.

raise aloft your dolphins and put forward your pinnace." Aristophanes does not say what sort of ship this was but a foot-note in the translation says it was a round-ship and adds that round-ships put forward their pinnaces or small boats as a defense against the ram; it is not however clear why they should do this. It is not likely long-ships used dolphins for their masts were short and the vessels very crank. Thucydides states that when Athenian and Syracusan long-ships were fighting in Syracuse harbor in 414 B C Athenian round-ships were placed at intervals to guard the approaches to the anchorage and carried dolphins aloft with which they destroyed 2 Syracusan ships: he writes,[3] "By fighting with all their might the Syracusans gained the victory and the Athenians turned and fled between the round-ships into their own station. The Syracusans pursued them as far as these vessels but there the beams that were hung from the round-ships over the passages between them with dolphins attached to them stopped their progress. Two however elated with victory came up close to them and were destroyed, one of them being captured with its crew."

ENGINES BATTER FORTS.

In 439 B C Pericles besieged the city of Samos and, writes Diodorus,[4] "He renewed the siege both by land and sea xx. He was the first who made use of those warlike engines called battering rams and scorpions." Scorpions were throwing-machines, probably small ones; both these and the battering rams were onshore and concern us little. Our next date is important: in 427 4 years after the Peloponnesian War began, by an Athenian fleet under Nicias, "By engines from the sea two towers on the Island of Minoa were captured." [5] This is engines onboard ships assaulting towers onshore and Aristophanes enables us to say they were throwing-engines; he writes,[6] "Now you shoot beyond Nicias with your engines,

[3] Bk 7, 41 Dale trans.

[4] V 1 p 450 Booth trans bk 12, 5: Thuc bk 1, 116–7 narrates this siege but says nothing of engines.

[5] Thuc 3, 51; Minoa is near Athens.

[6] Birds v 2 p 321 Bohn. In Excavations Babylon Koldewey trans Johns 1914 fig 34 is shown a pile of round stones running from 11 inches diam and 45 lbs wt to 6½ inches and 10 lbs, of limestone. The author concludes these were made in the day of Nicias and Aristophanes or later. In the same v figs 176–7 are shown highly curious objects; ancient boats built of earthen ware and of large size for 4-foot animals are depicted in them. There is an interesting record of stone projectiles in Antichita Romane Piranesi v 13 Adrian's tomb: the date is 125 A D: the plate showing these—they are unnumbered—is beyond the middle of the book. Nearly the same view is in v 4 pl 10. In the former plate piles of round stones the size of the head of the men shown are seen, being stacked as round shot are now stacked: others 15 or 20 inches diam are depicted.

Eleleleu Advance Present Beaks." In 406 there was an action between fleets near Mitylene and Adm De la Graviére says throwing-machines were used.[7] Xenophon and Diodorus both mention this battle; the first says nothing of missiles and Diodorus says,[8] "Many were killed by stones cast down upon them from the yards, which being both very big and thrown from a high place fell with the greater force and violence." This is not throwing-machines.

In 414 B C during the attempt to capture Syracuse Athenian round-ships had throwing-machines onboard; Thucydides writes,[9] "There was also some skirmishing in the harbor about the great stakes the Syracusans had driven in the sea in front of the old docks in order that their ships might lie within them and the Athenians might not sail against them and injure them by their charge. For the Athenians having brought to them a ship of 10000 talents burden carrying wooden towers and screens, from their boats fastened ropes around the piles and raised them with windlasses and tore them up or diving down sawed them in two. The Syracusans plied their missiles on them from the docks and the men on the round-ships discharged theirs in return; and at last the Athenians removed the greater part of the piles." Because places in the ships from which to fire engines and protection of these against hostile fire are mentioned engines were probably in the ships and onshore.

Our next circumstance is important: Diodorus says that in 400 B C King Dionysius of Syracuse, "Gets together all sorts of artificers some out of towns and cities of his own dominions and others hired with more than ordinary wages out of Italy and Greece. For he resolved to make a vast number of all sorts of arms and weapons; likewise ships both of 3-oars on a bank and of 5 which last were never used before xx. The art of making engines to hurl great stones was now first known at Syracuse for at this time the most excellent artificers were met together from all parts."[1] Aristotle who was about 350 B C 50 years after King Dionysius says the youth of Athens were taught, "To fight in heavy armor to draw the bow throw the javelin and to handle artillery," and in another place, "Under

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7 Mar des Anciennes v 2, 99.

8 Booth trans v 1 pp 550–2; bk 13, 11. Xenophon mentions the battle Hell bk 1, 6, 14–19.

9 Bk 7, 25: below p 146 as to size of the ship here mentioned.

1 Booth trans v 1 p 619; bk 14, 7. This has received much comment: see Freeman Sicily Story of Nat pp 157, 165; L'Artil des Grecs de Rochas La Nature, June, 1883; Poliorcetique des Greces Wescher. See Diod v 2 p 26; bk 15, 3, for bombardment of Naxos in 376 with engines from ships.

similar circumstances stone-throwing engines cannot shoot far xx." [2] In 333 at the siege of Tyre Alexander, "Loaded many little boats with engines to shoot arrows and darts," "Made a battery by joining many of his ships together and planted on them all sorts of rams and battering engines whereby he beat down 100 feet of the wall," and brought up, "As many of his ships as carried the shooting artillery or were built close for the convenience of archers." [3] The phrase "built-close" was used until after the day of Drake and meant that on the upper deck were shelters for the crew against boarding parties. There is an important record in days later than those of Alexander; the Tarentines used, "Throwing-machines called scorpions" from ships against a Roman army onshore in 280 B C.[4]

ENGINES IN SHIPS USED AGAINST SHIPS.

In cases so far ships are not using machines against other ships, that is in naval warfare proper. The earliest mention of this is of 306 B C in an action off Salamis in the Island of Cyprus between fleets of Ptolemy of Egypt and Demetrius: [5] Diodorus relates, "Demetrius now not a quarter of a league distant from the enemy gave the signal of battle which was the lifting up of a golden target visible to the whole fleet one part after another. Ptolemy doing the same presently the fleets joined and the trumpets sounded a charge and both fleets setting up a great shout to it they went in a dreadful and terrible manner. At first they made use of bows and engines to shoot arrows stones and darts by which many on both sides were grievously galled and wounded." [6]

A FORMAL INDICATION OF THE RANGE OF BATTLES.

Demetrius' fleet consisted of 108 vessels many of heavy rate; when in one line it must have been 3 miles long which makes signalling of interest. If the league was 3 miles the fleets were more than 5000 yards apart when they charged in line-of-battle and they had each 2500 yards to go before they met. They would form line-of-battle beyond the range of projectiles;

[2] Poste Trans Constitution of Athens p 79, Ch 42; Works of Aristo Smith and Ross trans v 6 the Audibilibus p 800a, 13.

[3] The first 2 are Diodorus v 2 pp 192–7; the 3d Arrian's Alexander Rooke trans 2d ed p 59 chap 23.

[4] Leo's Inst Mil trad Maizeroi v 2 p 324: Leo was Emp Constantinople 886–911 A D; he here copied from Frontin whose date is 100 A D. Tarentum is in the South of Italy.

[5] The date is from Mahaffy's Empire of the Ptolemys p 50: it is important in the history of gunnery.

[6] V 2 p 452; bk 30, 3.

but as the range of engines was less than 5000 yards, even their *random* or *rover* range, the names by which gunners of recent days and bow-men of long ago respectively called the extreme range of their projectiles, a distance of 2500 yards must have been deemed necessary for a ship to reach full speed and steady course as she charged. It will be noted our author says the effect of the projectiles became serious before the fleets met. Diodorus tells of the siege of Rhodes in the following year 305, "Demetrius therefore xx as ready prepared for a sea fight commanded his long-ships which carried engines on their fore-castles to cast darts and arrows 3 spans long to sail before xx," that he, "Got together a number of the strongest vessels and *fenced them round* with planks and boards and *made loop-holes in the sides* and in these placed engines to shoot darts and arrows 3 spans long at a great distance together with such gunners as knew well how to make use of them."[7] These were cross-bows on frames bolted in ships not beams swung by a weight or other means, for the latter could not project darts and arrows 3 spans long nor would loop-holes be used with them; that is Demetrius' ships used direct horizontal not indirect or vertical fire. The projectiles had burning brands attached so their flight and fall could be seen in order to correct fire and render it accurate as now practiced with *tracers*, burning attachments to the rear of projectiles.[8]

Demetrius came to be called Poliorcetes, Taker of Cities; besides using throwing-engines in ports he fitted the ports with shutters to close at will, covered structures with iron plates, seemingly to prevent being set on fire by the enemy,[9] and from him we have the first experiment in the penetration of armor: he, "Had 2 coats of mail brought from Cyprus xx. Zoilus the maker to show the excellence of their temper ordered a dart to be shot at one of them from an engine at the distance of 26 paces, and it stood so firm that there was no more mark on it than what might be made

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[7] Booth trans v 2 pp 475–477. It will not be forgotten war-ships in 1200 B C were fenced around for fight; see above p 31.

[8] P 487 v last cited; below p 450 for mention of tracers in mediæval days and the words of Demetrius.

[9] Diodorus v 2 pp 475, 479, 483, 487, 497. There is a mention of throwing-engines in a fight between fleets in 200 B C; one being commanded by the great Hannibal. From Hannibal's fleet, "The earthern pots xx began suddenly to be hurled xx, when they saw their ships filled with serpents xx they put about their ships and retreated to the camp on the coast;" Justin Cornelius Nepos and Eutropius Bohn pp 423–4. That the fleet had a camp onshore should be noted. Powerful cross-bows would break earthern pots so swinging-beams were used and the pots broke when they fell releasing the serpents within for explosive substances were unknown. This so far as I can

This is from Trajan's Column, 100 A D. The balistas in wagons are to be used in horizontal fire, for they fired long arrows, which would go end over end in vertical fire. They are no doubt like the scorpions Frontin says were used from ships against a Roman army in 280 B C. Several pictures more or less the same will be found pl 171 Ciacono ed Trajan's Column, Paris 1576: see also Froehner ed, 4 vs, a superb work; where pls 66 and 90 are balistas in wagons and description how they worked.

with such a style as is used in writing;"[1] but the resistance of armor was measured when it was first used.

SUMMARY NOTICE OF MECHANICAL GUNS: THEY LASTED LONG AND GAVE PLACE TO GUNPOWDER GUNS VERY SLOWLY.

Thus throwing-machines were used at early date and as will presently appear the day of the grand-parents of persons now living had come before they were laid entirely aside. They appear in 800 B C when Uzziah built them and first in ships in 427 and 306 B C, being the case of Nicias from ships against forts and Demetrius from ships against ships. Throwing stones and javelins by the arm, the former by slings and the use of the bow and arrow are all much older. The machines used in ships in Greek and Roman days were cross-bows mounted on suitable structures; in both ancient and mediæval days they were called by many names and this often aids in showing their nature. It is believed by many that after the day of the Greeks and Romans the art of making machines of the cross-bow description was in part forgotten. The swinging-beam machines because they employ only fire at high-angles and because the area of a ship's deck is small were perhaps never fired from ships at ships.

Mechanical artillery lasted long:[2] Folard who died 1752 400 years after gunpowder guns were common in Europe writes as follows; "It is hardly more than two centuries since catapults were used in the attack and defence of places."[3] Blondel says throwing-machines,[4] "Served the

recollect is the only mention of a swinging-beam throwing-machine used in a ship in battle, though the use of one from a ship in a special manner is mentioned in mediæval days; see below p 460. There is a remarkable passage of another character in this author (pp 423–4): Hannibal it reads, "Called the officers of his ships together xx and directed them all to make an attack on the single ship of King Eumenes and to be content with simply defending themselves against others xx"; Eumenes commanded the enemy's fleet. The directions are the same as those of Nelson in his Memorandum before Trafalgar. Nepos' day was 75 B C about 100 years after Hannibal. See below p 176 as to this battle.

[1] Demetrius Langhorne's Plutarch v 5, 133.

[2] Interesting details are set forth in works below; Abrege Com Folard sur l'Hist de Polybe, 1754: 3 large illustrated volumes. Blondel, Art de Jeter Bombes 1675. Machiavelli Treat on Art of War Eng trans; M died 1527. Gravière Dern Jours Mar à Rames p 72; striking quote from Montaigne who died 1592 and wrote fire-arms were about to be abandoned. Payne-Gallwey Proj—Throwing Eng Anc. Livy's Rome, bk 26, 47; the great number of machines found at Carthage when the Romans captured that city. Discours Conc Roman Art of War pp XCV–CIV; illustr trans Cæsar's Com Duncan. 1753.

[3] V 1 p 242 work cited.

[4] P 523 work cited.

ancients to throw into besieged cities stones heavier than our bombs," and Montaigne and Machiavelli express the opinion that gunpowder guns are of little effect: so long are great changes in coming about. When Syracuse was assailed by a Roman fleet 215 B C Archimedes built and erected, "Catapults to suit every range and as the ships sailing up were still at a considerable distance he wounded the enemy with stones and darts from the tighter-wound and larger engines xx and when these began to carry over their heads he used smaller engines graduated according to the range required. xx He had engines xx some of them carrying stones weighing as much as 10 talents and others great masses of lead." [5]

AIMING GUNS; RATE OF FIRE.

Guns of all kinds were aimed. In the day of the siege of Syracuse just alluded to were written the Comedies of Plautus where we read,[6] "Against whom the engine of mischief is now well-aimed which before long I shall discharge xx." Somewhat later Lucan writes in the Pharsalia,[7] "Nor is it now an easy task to the Greeks to direct their charges or to change the level of their engines-of-war adapted for hurling weapons at a distance." In Cæsar's Commentaries is the statement it was impossible to carry on certain work because man after man coming to do it is shot down by the enemy. This great soldier also tells this of gun-fire; [8] the Gauls, "Began to discharge by their slings hot balls made of burnt or hardened clay and heated javelins upon the huts which after Gallic fashion were thatched with straw." Hero or Hiero a Greek mathematician who was earlier than Archimedes wrote a description of mountings by which elevation could be changed and from this such a structure was built [9] and placed in the Museum of St Germain. There is early record of rapid rate of fire: Appian about 100 A D says the Roman general Sulla in 90 B C,[1] "Dis-

[5] Polyb bk 8, 7. Ten talents is about 600 pounds. These engines were of both varieties; cross-bows and others throwing stones weighing 600 pounds by swinging-beams. In Plutarch's Marcellus [Roman commander during siege] pp 243–8 v 2 Langhorne trans it is stated Archim built engines, "Suited to every distance" and, "Scorpions that did not carry very far but could be fast discharged;" see also Livy, bk 24, 34.

[6] Pœnulus p 361 Bohn.

[7] Riley trans Bohn p 115; bk 3: Lucan was Roman, died 65 A D.

[8] Gallic War, 7, 25 for first; 5, 43 for second; Bell ed pp 180, 128.

[9] Artil des Grecs de Rochas La Nature no 525 June 1883 p 9; see also Wescher p 457 below.

[1] Made Eng by J D, p 135; the bow was standing not portable.

charged from his greatest cross-bow 20 large leaden bullets at a time;" we have record also of a wonderful gun of Eastern origin,[2] "A self-charging cross-bow xx of Cingalese manufacture xx. It strings itself and discharges 2 arrows each shot in rapid succession until the magazine is exhausted which contains 12. The weapon is in the Un Ser Mus, Whitehall." Nothing is said of the date of this. Of portable bows the account is clear: English long-bow men could fire 12 well-aimed arrows a minute; they stood with ready arrows under the left foot which was advanced; Turkish bowmen who used shorter bows carried arrows hung on their left wrist; their bows' extreme or *rover* range was 850 yards, that of English long-bows 350.[3]

Appian writes in reference to operations in 140 B C between ships and shore-batteries at Carthage that Roman ships [the whole passage must be read to understand what is meant], "Received as much damage in the retreat as they had given in the charge, for as they turned about they were forced to receive all the blows of the shot from the Carthaginian engines on their broadsides. At last 5 ships which the city of Sidon allies of the people of Rome had sent xx dropped their anchors out at sea at a good distance from the Carthaginians, and giving scope of cable enough advanced by force of oars, and having given their charge warped back again by their cables which they had brought in at their poop; and thus again returned to the charge and in like manner retreated. All the fleet followed the example of those of Sidon."[4] The Romans charged turned with oars and retreated to make another charge, receiving much damage from engines on their broadside as they turned; and when they left an anchor to seaward were able to retreat after the charge by hauling on the anchor without turning and exposing their broadside. It is not apparent why charges one after another would effect much: but if there were many ships in small space after one was injured by a ram it would be worth while to draw back and charge again. This is not the only passage in ancient writings mentioning successive charges but none except one of Herodotus refers to damage to the ramming vessel;[5] for centuries fighting ships came

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[2] Wilkinson Engines of War p 27.

[3] Payne-Gallwey Proj—Throwing Engines of Ancients pp 17–26. Figures of Turkish bows are given; they differ from those used in Western Europe.

[4] Appian made Eng by J D 2d ed p 54: his date is 100 A D. This is referred to again in pp 187–8.

[5] Above p 88.

into contact but there is no clear mention of 2 meeting when both were moving at speed.

Evidently the Roman ships referred to by Appian suffered from the fire of Carthaginian engines situated onboard ships or onshore we are not informed which: they may have had power even to seriously injure the ships themselves for Cæsar says only timbers a foot square would give protection against engines; writing of the siege of Marseilles in 70 B C and engines used by that city, "No *vinea* made of hurdles could withstand their force. For poles 12 feet in length pointed with iron xx sank into the ground through 4 rows of hurdles. Therefore the arches of the vinea were covered over with beams a foot thick fastened together and under this the materials for the *agger* were handed from one to another."[6] These machines were made by the people of Marseilles not by Roman engineers.

The range at which engines were effective we have from Cæsar. He writes, "The 2 camps were not distant from each other above 2000 feet;"[7] that is this is the range of the missile arms in the camps. It follows from the context that Cæsar deemed the camps too close. Before his day throwing-machines were mounted on wheel-carriages but little is said of them in the Commentaries and nothing of comparatively large machines.[8] Armies and navies carried with them hair fiber or cord to make cross-bows and seasoned wood for bending parts but not machines and mountings complete; these were built when needed from wood cut near-by. This made engines portable, which made for their retention after gunpowder guns were available, for in the case of the last not only the gun and mount must be transported but a store of powder.

Throwing-engines carried in the field on wheels were used against elephants a number of which were brought across the Adriatic by Pyrrhus King of Epirus in 281 B C.[9] These were the first elephants brought into Italy and the field throwing-machines to combat them were called *carro-*

[6] Civ War 2, 1; p 291 Bell.

[7] Civ War 1, 82; p 287 Bell.

[8] See Gallic War 4, 20; p 94 Bell, in regard to his landing in Britain in 55 B C: he used engines in small vessels too heavy to be carried by men but it is not said they were on wheel-carriages.

[9] Armandi Hist Mil Elephants; p 279 special vessels for elephants and horses were built and the Carthaginians sent 140 elephants with an army in 250 B C into Sicily; p 528 Haroun-al-Raschid Caliph at Bagdad sent an elephant to Charlemagne by sea in 800 A D. In 1505 an elephant was sent from Ceylon around the Cape of Good Hope to Portugal; Albuquerque Stevens p 35.

balistæ. They were cross-bows of medium size and power mounted on wheel-carriages dragged by animals. Vegetius who wrote 350 A D says,[1] " Every century has a balista mounted on a carriage drawn by mules and served by a mess, that is 10 men; xx such is the violence with which they throw their darts that neither the cuirasses of the horse nor shields of the foot can withstand them." Throwing-machines on wheels appear on Trajan's Column, 125 A. D.[2] There is confirmation of Cæsar's statement as to camps 2000 feet asunder in the writings of an author who was considerably earlier: Agesistratos a Greek military writer of 200 B C says the extreme range of engines is 700 to 800 yards and that besiegers usually encamp at somewhat more than 1000 yards from the walls of a city.[3] The cases differ somewhat the last being in regard to engines on walls while Cæsar speaks of armies in the field; but the 2 bear one another out.

The killed and wounded were numerous for combatants remained long in contact. The actor in Æschylus' play tells Atossa Xerxes' mother that never did so many perish in one day as at Salamis, that the sea was covered with Persian dead; [4] and so we might expect for ships were locked together with grapnels and chains and the fighting hand-to-hand. Missile arms were used during the hand-to-hand fighting and had the field to themselves until contact: in Thucydides is a statement as follows; [5] " Any-one was killed who came in the way of the stones and arrows." Slung stones were of course more dangerous than those thrown by hand; but slings whether operated by one or both arms [6] were never much used in ships because of the space required. The number of bow-men and stone-throwers in a ship may well have reached 50 even when the ship was impelled by all rowers, the bow-men could discharge 10 or 12 arrows per minute and throwers 20 or 25 stones, and the range of arrows and stones was quite 200 yards. This was

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[1] Mil Institutions trans Clarke 1767 p 83. A picture of a balista on a carriage is above p 100.

[2] Col Trajane Ciacono Bartoli ed pls 30, 45: see pl 46 for a similar machine not on wheels: La Colonne Trajane Rothschild ed Paris 1872 4 vs in expl text as to pl 90 is description of working these engines.

[3] Proj Throwing-Eng Anc Payne-Gallwey p 10: also p 351 v 2 Inst Mil Emp Leo.

[4] Below p 123: see also p 171 for descriptions of fighting by several writers.

[5] Bk 4, 40.

[6] A man using a bar with both hands the bar carrying an ordinary sling is shown p 24 the ed of Vegetius Frontin and Ælian printed Paris 1536. The date of Vegetius is 375 A D, of Frontin 125 A D, of Ælian 100 A D. The treatises of Vegetius and Ælian have been trans into English. The illustr in the ed of 1536 are mediæval—of the age of the printed edition probably.

during approach: contemporary pictures showing the air full of projectiles are within the realities.

What is just quoted from Thucydides is in regard to the Peloponnesian War and belongs in 420 B C; at the other end of the day of long-ships, in 1402 A D, is written in Bethencourt's Conquest of the Canary Islands,[7] " A great number of Canarians had concealed themselves for the purpose of encountering us and a little time before they had beaten a party of our people and obliged them to retreat to their quarters with their heads bleeding and their arms and legs broken by the stones that were thrown at them. These people have no other weapons and believe me they can throw and handle a stone much better than a Christian can. It seems like a cross-bow when they hurl it." Though fire-arms were common 100 years before Bethencourt's day he had none; when writing of an encounter with the Canarians he refers only to, " Archers and cross-bow men." [8]

THROWING FIRE.

Explosives were developed by use of fire in war. Homer mentions sulphur an ingredient of gunpowder but in the way of burning not as a part of an explosive or in reference to throwing it to a distance.[9] This would be about 1000 B C and we find the same in the Book of Genesis about 2000 B C.[1] Herodotus says the Persians attacked Athens, " With arrows whereto pieces of lighted tow were attached " but does not mention sulphur. Thus one constituent of gunpowder was used in war 4000 years ago and to this have been added the other things necessary. Thucydides says besiegers of Platæa, " Threw also fire with sulphur and pitch which soon caught the wood." [2] Æneas the Tactician who lived 100 years after Thucydides writes, " To produce an inextinguishable conflagration take pitch sulphur tow manna incense and the scrapings of gummy woods from which torches are made, light the mixture and throw it against the object

[7] Hakl p 149.

[8] P 150 work just cited: thrown stones have been widely used in battle; as to their use by South Sea Islanders see Bligh Voyage of Bounty. Their use in Viking ships and the great number used is told in the Heimskringla particularly Prelim Dissert of Laing in his ed in 3 vs 1844: see pp 358 n 4, 397 below.

[9] Iliad p 147 prose trans Lang Leaf Myers.

[1] Ch 19, 24, " The Lord rained upon Sodom and upon Gomorrah brimstone and fire xx."

[2] Bk 2, 77: this was 429 B C.

you wish to reduce to cinders."[3] Appian says at the siege of Carthage in 146 B C Roman engines,[4] "Cast burning torches sulphur and pots full of flaming pitch." Here we have 2 ingredients of gunpowder, sulphur and carbon. In writing of games in Rome in 200 B C Livy says persons, "Carrying blazing torches ran down to the Tiber and after dipping the torches in the water drew them up again with the flame unextinguished because they were composed of native sulphur and charcoal."[5] If the tale is true as it well may be the torches contained not only sulphur and charcoal but an oxygen-containing substance like saltpeter, for burning charcoal and sulphur unless there is oxygen in the compound must draw this from the air. It is the oxygen-carrier that gives life to explosives. Long did men try to make violent burners; it was probably found accidentally that if what we call saltpeter is mixed with carbon the mixture burns violently, even projects itself, and from that to projecting something else was the next step.

The famous Greek Fire, Sea Fire it was also called because employed in sea warfare, marks the principal step in development of gunpowder. It is said to have been made known in Constantinople in 670 A D by Callinicus and its first service was to stop the Mahometans before that city by destroying the ships in which they had come. It was used in tubes in ships to vomit fire, project it as what we call a Roman candle does; and to do this must have contained a burner, carbon or sulphur perhaps, and a supporter of burning, an oxygen-carrier. This though correct proportions were not hit upon for years nor the mixture properly worked together was gunpowder.[6] It has been suggested that oxygen-containing substances may have been first noticed from fires built on soils where saltpeter exudes for with the carbon of the wood on fire conditions to produce explosion and self-projection are present.[7] It seems also that explosives were developed rather for use in religious ceremonies and games than in war.[8] Though vigorous burning mixtures were known in ancient days they

[3] Com sur Def des Places d' Æneas xx trad Beausobre p 168 v 1.

[4] Trans J D 2d ed p 55. See also p 368 same v.

[5] Bk 39, 13.

[6] It projected itself from tubes which shows it was gunpowder: see Feu Gregeois Reinaud et Favé; Etudes sur l'Artillerie Prince Napoleon et Favé, 6 vs superbly illustrated. See below p 438 n 2 for other works on the subject.

[7] Wilkinson Eng of War p 136: see p 140, description of a mixture made by Marcus Græcus who lived 800 A D containing 6 lbs of saltpeter 2 of charcoal and 1 of sulphur—practically gunpowder.

[8] Traité Feux d'Artifice pour le Spectacle par M F 1747.

[1] P 208 above for battle-plans.

were not often in ships: the earliest explicit mention of throwing one from ships seems to be in 38 B C; ships made,[9] "Constant charges and used missiles carrying fire," and we read little of fire used by ships until we come to the Sea Fire Feu Gregeois at Constantinople.[1] Yet ships of all times carried lights and therefore had fires. In ancient day lights were carried to be seen by consorts and as distinguishing marks and in later times when row-galleys cooked onboard their fires were never allowed to go out. We have description of a way of employing fire in war-ships besides throwing it: Livy tells of Rhodian ships in 190 B C with, "Two poles projecting from their prows carrying a great quantity of fire contained in iron vessels." [2] This arrangement must have attracted attention for it is described also by Polybius and Appian.[3] The plan endured long for we find it in illustrations of sea-warfare in the Middle Ages,[4] and it is like the spar torpedoes used by ships not long since, for the purpose of these and the pots of fire on spars projecting from the bows are both to prevent ram attack.

Thus throwing-machines were in use from pre-historic days until after the development of gunpowder guns. We have seen that those of the swinging-beam variety are pictured on stones and mentioned in the Bible in very ancient times and those of cross-bow variety mentioned in early Greek and Bible texts; and both varieties were in use as late as 1300 A D when gunpowder guns were comparatively common. In the Siete Partidas of Alfonso the Wise King of Leon and Castile 1252 to 1284 is a part headed, "Of War and Things Necessarily Pertaining to It" where it is prescribed, "Kings and Other Great Men" must have abundance of, "Engines that throw stones by counter-weights and others that throw them by cords of hand besides many cross-bows and bows and other things

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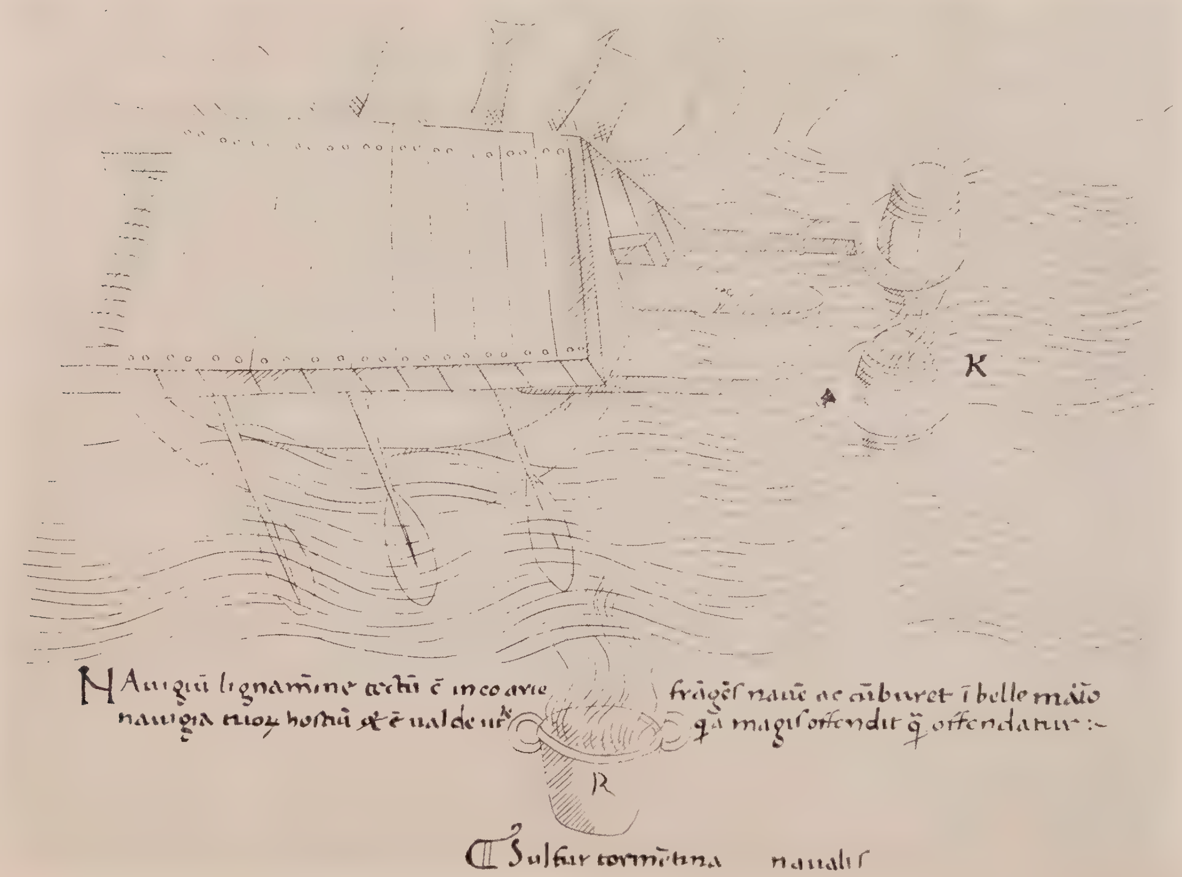
[9] Dio's Rom Hist Foster ed v 3 p 208.

[1] Pl 3 figs 34, 35 Book Plates Reinaud and Favé's Feu Greg show contemporary pictures of Arab ships of 1280 on the deck of which are pots intended probably to contain Greek Fire: figs 36, 38 show throwing-machines operated by swinging-beams but not onboard ships. A throwing-machine of this class is shown onboard a ship p 49 v 1 Cordier's Yule's M Polo, of which the details Yule says were supplied by himself: it represents a Venetian galley going into action in 1280. As has been mentioned a ship in a fleet commanded by Hannibal had machines of this class in 200 B C but it is unlikely they were often in ships.

[2] Livy 37, 11, Baker trans; see 37, 30 for description of this at Battle of Myonnesus the same year.

[3] Polyb 21, 7, Shuckburgh trans: Appian trans J D 2d ed p 72.

[4] Pl 12 and 13 Reinaud and Favé Feu Gregeois: a Latin version of the legends on these pictures is p 281 of the work itself.



From pl 13 Feu Gregeois, Reinaud and Favé: it is from a mss of about 1350: the writing at bottom is in part, "Vessel with wood covering. x x A vase containing burning substances." At bottom, "Sulphur and tormentum for ships."

which throw arrows, and even slings which throw by hand and others which throw by 2 hands xx."[5]

NAVIGATION.

Examination of finding position at sea is in the part about round-ships for long-ships made voyages by running from one intermediate port to the next being directed by pilotage, only seldom having occasion to find position in the open sea. They made voyages without being out of sight of land, lying in harbors at night and when the weather was bad or wind contrary. Pilots were obliged to know not only the ports, sheltered and land-locked harbors along the way they were to go, but where smooth beaches sheltered from surf were to be found for long-ships were run aground to land their people.[6] If the sea was smooth they touched the beach to let the people land; if there was a surf and heavy weather threatening ships were hauled up so far the breaking sea could not reach them. Pilots knew where good water could be found for long-ships carried small supply and much was needed. It was necessary for them to know how to determine direction and to keep a reckoning of the course and distance to harbors or refuges near-by, which is the same as keeping account of where the ship is at all times, for they might be blown out of their course or out of sight of land. From very early days a reckoning was kept, particularly in round-ships for these crossed wide arms of the sea. The Mediterranean is narrow and the bearing of the sun and stars changes little because of change of latitude. Thus the bearing of the sun or star, angular distance from any point of the horizon, is the same everywhere on the same day and hour of a year; and pilots knew these angles and steered by them. They carried them in the head probably—2 or 3 bearings on each 5th day perhaps; and beginners carried tables of them. It is easy to reduce bearings to a system to be memorized; the sun moves about 25° in azimuth in 3

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[5] Siete Partidas xx por la Real Acad de la Hist Madrid 1807 3 vs v 2 p 226 (titulo 23 partida 2): p 258 (tit 24 part 2) is, "Of War on the Sea;" boatswains dress in bright red stuffs; pilots are made because of wisdom, they must, "Be wise in knowing all things of the sea in the region they are in the currents and winds and their changes and all other sea-wisdom (the word is *marineria*). And besides must know the islands the ports and the sweet waters where they are and the ways of entering and leaving to guide the ship safely xx. If by mistake or fault of bad guidance the vessel is lost or those in her receive great harm he shall die for it." The allusion to clothing is among the earliest of its kind. Of the same date and in another work we read of, "The clothing of seamen," as though it were distinctive; Bibl Autores Esp v 66 Chron Rey Alfonso el Sabio chap 72 p 55.

[6] Above p 12.

months and its bearing at a fixed hour of day changes less than $^1/_3{}^\circ$ per day: the bearing would be for purposes of steering the same for quite 10 days. The changes through the day are more; at the equinox 180° and at the solstice 130° to 225° per day, 5° to 10° per hour; but if this were tabulated for different hours of the day and the last ascertained by an astrolabe or hour-glass direction could be determined. Astrolabes could be marked; and those who did not wish to calculate the curves on their faces or were not able to do this could mark by observing with one at each hour of each day through a year. When the curves were thus established by trial instruments could be marked.

PILOTS AND STEERING.

The Greeks called pilots *kubernetes*. They held the helm in ancient and mediæval days. Their hours were long and they had an *agklima* [8] to sit or lie on. Greek long-ships were steered by oars on opposite quarters provided with a rope bridle called *itunthere* by which these moved together.[9] Ships of mediæval day employed similar methods; the pilot of the long-ship in which Felix Fabri went to the Holy Land about 1480 had the helmsman with charts and necessary things in an elevated and sheltered room; [1] round-ships were probably not so arranged but steered by men in the open. The modern steamer has resumed the ways of long-ships; her helmsman together with charts and books of sailing-directions are in a sheltered place.

Small vessels used oars on one or both quarters to steer with but large ships of high freeboard must have used rudders like those now employed. The ship of Lucian of 200 A D had a rudder like those of today and Herodotus describes how ships are built with planks laid along held together by bolts and have a rudder driven through the keel.[a]

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[8] Greek dict give this as meaning to lean one thing on another, to lie sloping upward; Cartault Triere Athen p 47; Serre Mar de Guerre v 2 pp 361–2. The Northmen who if we did not know the contrary we might suppose built long-ships on Greek patterns, had also a seat for the pilot; below pp 399 n 1, 427.

[9] V 2 p 197 Serre; Cartault pp 102, 104, 106; Serre p 356 as to oars for steering. In an inventory of ships' stores discovered 80 years since an entry reads, "Number of rudders, 469, providing 234 ships; one surplus rudder:" see Cartault p 102 note for the inscription and p 356 note v 2 Serre for its translation.

[1] Below p 294.

a Herod bk 2, 96. See p 204 below as to Lucian's ship.

CHAPTER III.

LONG-SHIPS.

War on the Sea about 500 B C;
Wars of Persia on Greece Beginning with the Battle off Lade 496 B C:
the Ships and Life in Them.

Fighting was almost continuous in the Mediterranean throughout the 500 years preceding the Christian era. The records are clear and satisfying and as we follow them the thought arises that the sea was of greater consequence then than now. Operations of peace, the coming and going of round-ships, were also vital in early time, for as now cities and regions densely peopled were provisioned and supplied by sea and ships carried from such places the surplus of manufactured goods. There were roads but pack-animals or wagons cannot carry considerable weights a long distance,[2] and where roads were poor or non-existent and regions to be passed uncleared or occupied by hostile people there was no transportation by land.

THE STATE OF SEA-WARFARE IN 500 B C.

Before following the Persian Wars on Greece it will be well to review the science and art of war as practised in the Mediterranean in 500 B C. A wonderful thing it is that the art was finished and understood at this date; from which we must conclude its beginning lies in pre-historic days. It has been mentioned that the term *war-ship* is found in Egyptian records of date 2500 B C; and Herodotus, called the Father of History, gives description of a fight off the Indus in about 1300 B C; perhaps an echo which reached him in Egypt of the battle in 1200 B C off the Nile pictured on stones in Egypt.[3] He tells of Egyptian and Tyrian fleets fighting off the coast of Phenicia in 580 and allied Carthaginian and Etruscan ships against Greek Phocæans off Alalia in Corsica in 535. In his account of the last he tells of the use of rams but of the others gives no

[2] The roads of the Romans are celebrated; Polybius writes (3, 39, 8) in 150 B C that the roads in South Gaul had been measured by pacing and marked by distance-stones set up and roads nearer Rome had been completed earlier. See Tozer Anc Geog p 235.

[3] Above p 31.

details:—at Alalia he says [4] the Greeks were victorious but lost 40 of their 60 ships while, " The 20 that remained came out of the engagement with beaks so bent and blunted as to be no longer serviceable."

The narrative must be arrested to notice these words, that beaks were bent and blunted by ramming, for in the accounts of ram-fights almost innumerable it is the clearest and almost the only allusion to injury done to ramming vessels. Thucydides says Syracusan ships stove in Athenian ships in 415 B C by meeting them with strengthened and stiffened bows.[5] We readily believe vessels injured their bow by ramming for that would occur now and may conclude they were often incapacitated by ramming once.

Thucydides says,[a] " Minos was the first to acquire a navy " and that he did this for the better coming in of his revenue. Minos was King of Crete about 1250 B C and the ports of Crete lying across the ways between Greece Tyre and Egypt were great emporia. The same author says there were penteconters and trieres in the battle off Alalia in 535 B C and knew of a battle earlier than this; one between Corcyra and Corinth in 664 B C but supplies no details of this.[6] Of the arrangement of fleets in lines-of-battle the distance apart at which they formed and how they advanced to attack historians say enough to make it possible to discover these. They formed in one line abreast usually as close to each other as their oars made advisable and beyond reach of the enemy's missiles and charged with missile-arms in use, javelins bows spears thrown and slung stones etc: upon meeting the crews fought with sword and shield the missile-arms continuing to play. The rowers and fighting-men, usually separate classes, were protected by a bulwark which was raised when about to go into action; there were protected crow's-nests at the mast-heads with bow-men and slingers in them and raised and protected platforms at bow and stern for men to fight from.[7] Homer mentions, " Jointed pikes shod at the head with bronze " and, " A great pike for sea-battles jointed with rings 22 cubits

[4] Bk 2, 102; 2, 161; 1, 166: above p 88 for his words and those of Thucydides as to Alalia.

[5] Below p 145: below p 490 and n that p for damage to mediæval galleys when they rammed.

[a] Bk 1, 4.

[6] Bk 1, 13.

[7] In the picture of the battle at the Nile-mouth above p 31, crow's-nests slingers raised platforms and protecting bulwarks appear.

in length."[8] Raised platforms at bow and stern have been used in all parts of the earth to make ships ready to fight: in the Odyssey we read,[9] "I did on my glorious harness and caught up 2 long lances in my hands and went onto the decking of the prow" and such platforms are used in modern days.[1] Bows and arrows were used and stones thrown by the hand and by slings operated by one or both arms.[2] Slings of the last kind were attached to a wooden staff held by both hands and whirled about the head. A stone thrown by hand would be dangerous at 200 yards and slung stones or arrows at greater distances.

Missiles were thrown from ships by men while seated because of the crankness of vessels and because throwers as well as heavy-armed were posted on the catastroma deck, 8 or 10 feet above the water: Thucydides represents a fleet-commander addressing his men as follows,[3] "They have on deck contrary to their custom many heavy-armed and many so to speak landsmen-darters Acarnanians and others who will not even know how to launch their weapons sitting; how should they do aught else but sway the ships about." The time ancient fleets were approaching during which missiles alone were used was short. Before the introduction of standing throwing-machines the range of missiles could not have been as great as 4 to 5 hundred yards; and as the ships could cover half this in about a minute missiles were used during this time and afterwards when ships were

[8] Iliad Lang Leaf Myers trans pp 302, 311. The jointed pike was of variable length to be used according to the distance of ships; like jointed gun-rammers of 1500 to 1850 A D, used when ships were close: Fournier in 1667 in a list of stores in his 2d ed p 135 mentions *refouloirs de corde avec leurs ecouvillons:* this was a gun-rammer consisting of several short circular cylinders fitting the bore united each to the next by a cord; there were also loose sticks each the length of cord between the cylinders; upon inserting the cylinders one by one in the gun with a stick between each pair the apparatus was rigid enough to push a charge to the bottom of the bore. It was drawn out by the cords: see word *ecouvillon* Larousse's Encyc. There is a description of these in an English book of about 1800 A D but I cannot now find it.

[9] Butcher and Lang trans p 199.

[1] Below p 171.

[2] Above p 109.

[3] Bk 7, 67 Bloomfield trans; Serre Mar de Guerre v 2, 18. The heavy-armed wore armor and carried sword spear and shield; they were soldiers not seamen and fought hand-to-hand when ships grappled: they were of a social caste higher than seamen. Such speeches as this are found not uncommonly in ancient authors and though put in the mouth of speakers by historians are often very informing. See below p 135.

in contact. Modern fleets opening at 10000 yards and approaching at speed have their guns in action about 5 minutes.[4]

THE DOMINION OF THE SEA.

The ancients set great store in power at sea. Pericles addressed his countrymen before the Peloponnesian War broke out as follows,[5] " Nautical skill is as much as any other thing the work of art and does not admit of being pursued at chance times, nay it rather allows not anything else to be done with it. xx If the enemy should invade our territory by land we can attack them by sea and affairs will not be on an equality for even a part only of the Peloponnesus to be ravaged and the whole of Attica for they will have no other territory to occupy instead xx. To us there is considerable territory both on the islands and on the main-land. Of vast consequence indeed is the dominion of the sea; for consider, had we been islanders who would have been less open to attack than ourselves." [6] Pericles having commanded a fleet speaks with knowledge and authority and his words are a formal expression of the doctrine of sea-power, a principle much held to in ancient days [7] but one which not all considered wise: Isocrates who was about 25 years of age when the power of Athens was broken at Ægospotamos in 405 B C writes, " It is not expedient that we should retain the sovereignty of the seas." [8]

[4] A comparison of ancient and modern density of fire may be made: present-day automatic small-bore guns shooting 600 bullets per minute at such muzzle velocity that they fly 1800 feet in the first second will keep 10 bullets in the air between the gun and a point 1800 feet distant; a bullet every 180 feet. A slinger using both arms could probably make a stone go 300 feet in the first second; if he throws every 2 seconds his stones will be 600 feet apart in the air. A man can throw a stone with the unaided arm 100 feet in the first second; if he throws one every second they will be 100 feet apart. The kinetic energy of a bullet from the automatic is 10 times that of the stones; and as the diameter of the latter is 10 times that of the former the concentration of effect is to be increased further in this ratio. The fire of the ancients was however formidable; Thucydides bk 2, 81 says that because of slingers men could not venture from behind ramparts without putting on their armor. Because the number of men throwing—all but the rowers and after ships met all but the heavy-armed—was great, much greater than the number of guns now firing; it is possible there were more projectiles flying than now.

[5] This was almost purely naval: its course may be followed in Thucydides, Grundy's Thuc and Hist of His Age, Bury's Greece or Grote's Greece. Grundy p 314 writes, " The Athenian Empire rose and fell with the Athenian navy."

[6] Thuc Bloomfield trans bk 1, 142–3.

[7] For cases of the use of the word *thalassokrateo,* sovereignty of the sea, see Greek lexicons. In Hall's Anc Civilization of Greece will be found a table showing when ancient nations are deemed to have been sovereigns of the sea.

[8] Orations Isocrates Dinsdale trans 8th ode p 185.

From Trajan's Column and of same nature as that shown p 100 above: the two balistas here shown include a detail not in the former; the fire of such machines was formidable for the thickness of the defence of logs cannot be less than four or five feet. More than one man throws stones and one is using a sling—the last shows how ready stones were carried.

Pericles did more to secure power on the sea than make speeches for he established a squadron of evolutions a training squadron; " He sent out every year 60 trieres," we are told,[9] " on board of which there went several of the citizens who were in pay 8 months learning at the same time and practising the art of navigation that they might prove good seamen." The date is about 430 B C, immediately after the Peloponnesian War began; we do not know what citizens were required to learn.

THE PERSIAN WARS ON GREECE: BATTLE OFF LADE 496 B C.

Lade was an island off the south-west coast of Asia Minor near Miletus. The battle occurred on coming of a Persian fleet consisting of Phenician Egyptian Cyprian and ships of other nations in the east of the Mediterranean previously conquered by Persia whose purpose was to reduce Greek islands near Asia Minor. It was not accompanied by a land force. There were 600 ships in the Persian and 353 in the Greek fleet, the latter being assembled from the numerous and independent Greek states and islands. The vessels of the 2 fleets were trieres 3-oar ships of the same class.[1] They had not an end-to-end deck below the oarsmen nor a catastroma deck above them with fighting men posted on it,[2] the fighting men being on the thwarts with the rowers. Herodotus says the Greek commander-in-chief,[3] " Proceeded every day to make the ships move in column and rowers ply their oars and exercise themselves in breaking the line while the seamen were held under arms and the vessels kept until evening fell upon their anchors so that the men had nothing but toil from noon even to night." The men refused duty after 7 days and continues Herodotus, " Pitched their tents on the island as if they had been soldiers where they reposed under the shade all day and refused to go onboard their ships and train themselves. xx The Persians soon afterwards sailed to the attack and the Greeks likewise put themselves in line and went out to meet them. When they had now neared one another and joined battle which fought like brave men and which like cowards I cannot declare with any certainty. The Samians xx bore away for Samos xx the Lesbians also. Of those who remained and fought none were so rudely handled as the Chians xx. They xx oft-times cut the line of the enemy until at last xx they ended by losing

9 Plutarch's Pericles Dacier trans p 158: Plut was a Greek born about 45 A D.
1 Above pp 74 and foll'g as to how they may have rowed.
2 Above p 89.
3 Bk 6, 7–15.

more than half their ships. Hereupon xx the Chians fled away to their own country."

Herodotus our only authority respecting this battle says the fleets formed line, presumably single lines with bows towards the enemy, charged and charged again. From his words we conclude the ships were continually moving—a circumstance which disappeared in large degree when war-ships used sails—and that the lines were cut more than once; also that before the arrival of the Persians the Greek ships practised among themselves in breaking the line. Both when practising and fighting the ships must have guarded their oars from being broken. It cannot be ships were so far apart in line that opposing ships could pass in open water between the ends of oars, oars being in action. Ships as they went through a line of friends or foes must have trailed oars alongside, but this is not mentioned by the authors; it would be impossible to trail quickly 3 horizontal lines of oars or 3 lines arranged zenzile,[4] which suggests the supposition of Admiral Serre; that in battle trieres rowed only their upper oars putting 3 men on each.[5] Then oars could be trailed quickly and by the rowers turning themselves about ships could be backed or turned with powerful strokes.[6] Though we have no description of how ships saved their oars they were alive to the danger: 500 years after Lade Cæsar refers to breaking oars; mentioning, "Running across our ships and carrying away our oars" and, "Running alongside and breaking the oars." [7]

As to other matters Herodotus' description of the Greeks at Lade: The tents were brought by the ships and pitched onshore for the men to repose and sleep in. No long-ships cooked onboard and men landed for meals and water enough for one or two days only was onboard. When about to land ships dropped an anchor to seaward and hauled their sterns to the land and lightly aground with a hawser to the shore.[8] The men deemed

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[4] Above pp 77 and 81 as to trailing oars.

[5] Above p 80.

[6] Above p 87.

[7] Civ War 1, 56 p 274; Alex War p 386; Bell ed.

[8] There are allusions in the ancient authors to drinking and drinking-cups and some show how water may have been carried; in Athenæus' Deipnosophists Bohn 3 vs v 2 p 771,

"But come now, with your cup in your hand
Move o'er the benches of the speedy ship
And lift the covers from the hollow casks;"

remaining onboard for 7 days a great hardship, and this it no doubt was when as must have been the case before Lade the ships were full manned.

THE PERSIAN WARS ON GREECE: THE THREE EXPEDITIONS SENT.

Following Lade the Persians sent armies 3 times against Greece, in great measure by sea. Before narrating these it may be well to collect passages concerning methods of the Persians in war: Herodotus says the King of Persia,[9] " When he goes to war xx is attended by a number of four-wheel cars drawn by mules in which the Choaspes water ready boiled for use and stored in flagons of silver is moved with him from place to place." Persian armies had general staffs, for Arrian says at Arbela, 331 B C,[1] " Darius' army was drawn up in this manner for the description thereof xx was found in little books after the battle ": but Persian soldiers were poorly equipped for Aristagoras a Greek told the King of Sparta when endeavoring to persuade him to send an army into Persia;[2] " Their mode of fighting is the following; they use bows and arrows and a short spear they wear trousers in the field and cover their heads with turbans. So easy are they to vanquish."

The first Persian expedition assembled in Cilicia in the south-east of Asia Minor 492 B C: Mardonius its commander Herodotus says,[3] " Took ship and proceeded along-shore with his fleet while the land army marched under other leaders toward the Hellespont." The army was carried across the Hellespont in ships, the fleet was caught by a gale off Mount Athos a short distance west of the Hellespont and 300 ships foundered or were destroyed in the breakers; and so, writes Herodotus, " This armament having failed disgracefully returned to Asia." A second expedition set out

and same p,

" They leapt into th' horse-transports gallantly
Buying cups, but some bought instead garlic and onions."

The last passage is copied from the comedies of Aristophanes and indicates that a drinking-cup was a part of the store of seamen as were garlic and onions. See below p 489 as to water carried into ships by the men in mediæval day.

9 Bk 1, 188.

1 Hist Alex trans Rooke 2 vs bk 3, 11. The oldest reference to a plan drawn up for a sea-battle seems to be Lepanto 1571 A D, " Each captain was furnished with a copy of the general instructions;" see Stirling-Maxwell's Don John of Austria v 1 ch 15 p 328, and below pp 506–7. Reports of admirals are common; Nicias made one in 415 B C, and one was made of a second battle off Lade in 201 B C; Thuc 7, 10–15, Polybius Shuckburgh trans 2 vs, bk 21, 14–15: above p 83 n 2 as to the last.

2 Herod bk 5, 49–50: see also in this place the map by which Aristagoras explained to the King where Persia was; above pp 22–3.

3 Bk 6, 43–5.

from the same place in 490 under Datis and Artaphernes. The soldiers went by ship [4] probably themselves rowing and to avoid Mount Athos crossed the Ægean Sea among the islands. Herodotus says [5] the fleet being on the west coast of Asia Minor east from Athens, " Thence instead of proceeding with a straight course along the shore to the Hellespont and to Thrace they loosed from Samos and voyaged across the sea through the midst of the islands." This passage is often cited to show that ships never went out of sight of land. The way Herodotus calls straight, by the shore to the Hellespont, is 3 times as far as across among the islands. It is possible that for a fleet of many long-ships the voyage across among the islands was unusual, but the route was often taken; Homer tells of a ship which 500 years before, " Cut the wide sea sheer athwart " in the same place.[6] The earlier voyages from Crete to Egypt and from Phenicia by way of Crete to the north shore of Africa recounted by Homer also show how common it was to cross wide stretches of sea. Perhaps fleets of numerous long-ships considered the run across the Ægean, though here islands are always near, a dangerous undertaking. We shall see that Nicias took the fleet Athens sent to Syracuse in 415 B C by the long detour following the south shore of Italy.[7] The direct course to Syracuse is much longer than the way Datis and Artaphernes took and there are no intermediate islands.

This expedition also failed; the army landed in Greece and was defeated by the Greeks under Miltiades at Marathon. The fleet consisted of 600 trieres and a number of horse-transports and as the distance covered was 800 miles the voyage must have taken full forty days, the men being probably landed every night unless the wind was fair and weather pleasant. The horses must have caused anxiety and a failure to carry them in condition was perhaps a principal cause of Persian defeat. It has been estimated there were 10000 horses and the plain of Marathon was selected for disembarkation because a good place for the operations of horse yet Herodotus says nothing of them; nothing of their being landed for recreation during the voyage of their disembarkation or subsequent embarkation in Greece or use in the battle. To land and reëmbark 10000

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[4] Herod bk 6, 95–117.

[5] Bk 6, 95.

[6] Odys Cowper trans Bohn v 8 p 35; bk 3 line 212.

[7] Below p 144.

horses is no light undertaking; even to provide fodder and water required careful planning.[8]

Herodotus says nothing of the disembarkation of the Persians and it was probably unopposed. Of their reëmbarking after the rout at Marathon he writes, "The Athenians hung upon the run-aways and cut them down chasing them all the way to the shore on reaching which they laid hold of the ships and called aloud for fire. It was in the struggle here that Callimachus lost his life and Cynægirus having seized on a vessel of the enemy by the *aplaston* [9] had his hand cut off by the blow of an axe and so perished. The Athenians captured 7 of the vessels while with the remainder the barbarians pushed off." The ships had probably an anchor to seaward and the men were fighting in water to the knee or waist.[1]

Rawlinson in a note in his Herodotus at this place estimates the Persian force at 210000 men of which 10000 are horse. The only number Herodotus gives is that of the trieres, 600, which as a triere had 200 rowers would call for 120000 men; and because the fleet must have included round-ships to carry stores and provisions the whole number may well have exceeded 200000. To transport these 800 miles land them with only the loss of the services of the horse, and so dispose the ships—they could not have been beached in a length less than 5 miles—that the flying army escaped by leaping into the ships as they might leap on horses is an operation which may well give pause. Modern ships could carry a force 800 miles in 24 hours; if we could embark and disembark as quickly and surely as the Greeks great results might follow.

The Persian King spent years in preparing a third expedition. It came in 480 by land and sea under command of King Xerxes himself and was in effect destroyed by defeat of its fleet in Salamis Bay. After this

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8 In Gr and Rom days and throughout the Middle Age horse-transports are often referred to: horses entered ships by doors in the stern partly under-water when the ship was trimmed, as illustrated by this ballad of about 1300 A D:

> "I tell you a zest far before
> Aught of slumber or drink or of food
> I snatch when the shouts of *Alor*
> Ring from both sides; and out of the wood
> Comes the neighing of steeds dimly seen:"

Cordier's Yule's M Polo v 1 p 44 Introd. *Alor* was the battle cry; the horses are partly below water, not easy to land.

9 The upward and forward-curved piece at the *stern* on which a scroll identifying ships was carved: the ships had been hauled onshore with sterns land-ward. See below p 431 n 6.

1 Below p 181 for flight of a defeated force to ships in 217 B C.

battle,[2] Xerxes fearing Greek ships would go to the Hellespont and destroy the bridges he had built for his army to cross and by which he expected to return, " Made up his mind to fly." So the main force withdrew leaving Mardonius with 300000 men; he was defeated at Platæa the following year. The story of this expedition perhaps the most colossal military movement ever undertaken is told by Herodotus in the places cited in the note next preceding.

Before giving the movements and fighting of the ships it will be best to state the Persian force and describe the bridges across the Hellespont and canal at Mount Athos. Herodotus says there were 1207 Persian ships and 517610 men, and as the complement of the triere was 200, a number which completely filled her, more than ½ these men, since 1207 multiplied by 200 is 241400, must have been in round-ships or have marched by land. The number of fighting-men of all services in the original force Herodotus says was 2317610, to which he adds 300000 forced to join the army while on the march.[3] This makes the total fighting-men he says 2641610;[4] to whom he adds, " The attendants who follow the camp together with the crews of the round-ships and other craft." These he estimates equal to the number of fighting-men; which he concludes, " Gives 5283220 as the whole number of men brought by Xerxes the son of Darius as far as Sepias and Thermopylæ. As for the number of women who ground the corn and of the concubines and the eunuchs no-one can give any sure account of it; nor can the baggage-horses and other sumpter-beasts and the Indian hounds which followed the army be calculated by reason of their multitude. Hence I am not at-all surprised that the water of the rivers was found too scant for the army in some instances;[5] rather it is a marvel to me how the provisions did not fail." [6]

On 2 parallel bridges the army crossed the Hellespont, which at

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[2] Herod, 7, 20–237; 8, 1–97.

[3] Bk 7, 185–7.

[4] There is here error.

[5] If the number of men women and beasts was 10000000 and each used and wasted ½-gallon water per day they would require a stream 10 feet wide 6 inches deep running 90 feet per minute,—a little more than 1 mile per hour. Such a stream is a small river and they are few in the line of march from the Hellespont to Thermopylæ: the season was late summer when streams would be low.

[6] As far as the Hellespont provisions could have been stored while the expedition was preparing but beyond Greek influence prevailed and this could not have been done. If the force required 5000000 pounds of corn a day, about 2500 tons, it would empty 2 large round-ships loaded with corn each day; other food also was necessary to keep the force in health.

Abydos where these were is more than a mile wide is deep and runs outward swiftly. The bridge nearest the Black Sea was supported by 360 trieres and penteconters the other by 314. These were moored in the stream and across the lines of vessels was carried 6 cables to support the road-way. The cables were of papyrus and flax and the last weighed a talent to a cubit length. As cables are now made this weight would be reached by one 6 inches in diameter—a very large rope; but as Xerxes' cables were made by the power of men or beasts they could not have been as tightly twisted as ours; so they must have been more than 6 inches in diameter.[7]

To avoid rounding Mount Athos where many Persian ships had been lost [8] Xerxes cut a canal within the extremity of the promontory on which Athos stands. Its length was about 1½ miles and its width since Xerxes required this should be sufficient to allow trieres with their oars in action to pass about 150 feet: traces of its remains have in recent days been found.[9] It adds to our knowledge of ships and methods of the day to read Herodotus' statement that Xerxes built the canal, "Wishing to display the extent of his power and to leave behind him a memorial to posterity. For notwithstanding it was open to him with no trouble at-all to have had his ships drawn across the isthmus yet he issued orders that a canal should be made through which the sea might flow and that it should be of such a width as would allow 2 trieres passing through it abreast with their oars in action." Trieres weighed about 50 tons and there were 1207 of them; a *diolkos,* a ship-railway like the one at the Isthmus of Corinth 5 miles wide to run ships across the peninsula of Greece, would be built over the ground.[1]

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[7] Herod says these cables were afterwards brought home by the Greeks; bk 9, 121: Athenæus writing 600 years later compares them with the anchor-cables of large Egyptian ships, Deipnosophists bk 5, 44; p 333, v 1, Bohn ed. Major Rennel, Geog System of Herod, gives maps showing where the bridges were as well as earlier ones across the Dardanelles and Danube. The vessels were not far apart; 360 ships 20 ft beam would occupy 7200 feet 1⅓ miles.

[8] Above p 117. z

[9] Rawlinson's Herod v 4 note p 20: the width stated is based on Serre Mar de Guerre v 1 p 34 where the oars of trieres are put at 23 feet long.

[1] Serre Mar de Guerre v 1 p 35 for tonnage of trieres. As to *diolkos,* in Greek dictionaries definition and instances of the use of the word will be found. As the word *olkas* means a burden-ship round-ship the name *diolkos,* applied to the *place* in the Isthmus where this was, may have arisen from the fact that round-ships were here conveyed across; the place may have taken its name from the ships. There were cradles on wheels or rollers to carry the ships and hawsers and capstans to drag these. Long-ships do not seem to have crossed the Isthmus: when they carried cargoes these being small could be carried across and these vessels were too lightly built to support the strains of transportation. See p 143 below.

MILITARY OPERATIONS PRECEDING SALAMIS.

To dispute the advance of the Persians the Greeks posted a force in the Pass of Thermopylæ and to prevent a force landing in its rear posted the fleet north of the Pass. It took station at Artemisium and here fought 3 times but Herodotus gives details of the first of these actions only, writing,[2] "The Greeks at a signal brought the sterns of their ships together into a small compass and turned their prows on every side towards the barbarians after which at a 2d signal xx they fell bravely to work." The number of ships is not given, but the Persians were probably most numerous for they had in all 1207 and the Greeks 378.[3] Confirmation of Herodotus' figures is found in a speech of Demosthenes in Athens 125 years after the coming of the Persians; he said, "The King of Persia knows right well that by 300 ships whereof we furnished 100 his ancestors lost 1000."[4]

RADIAL BATTLE FORMATIONS.

Besides the one given there are 3 mentions of fleets forming radially; all as at Artemisium in presence of superior force.[5] The easy way Herodotus refers to battle signals and obedience to them should not be overlooked.

BATTLE OF SALAMIS.

The Persians failed because of the bold front shown by Greek ships at Artemisium to reach the rear of Leonidas in the Pass by sea but found a guide to take them there by land; upon which the Greek army retired to Athens the Persians following, while the fleets kept abreast of the armies. Before Athens October 20, 480 B C was fought Salamis bringing to an end the attempt of Persia to conquer Greece. The battle is described best in a play called The Persians written by Æschylus who fought in the Greek fleet. It was put on the stage in Athens 8 years after the battle and represents that Xerxes after defeat sends a messenger to his mother Atossa at Susa the Persian capital. Atossa asks who began the fight and the messenger replies a Greek having told Xerxes Greek ships were preparing to fly from Salamis Bay during the night the King directed the Persian com-

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2 Bk 8, 11: see bk 8, 16 for half-moon or hollow half-circle formation.

3 Herod bk 7, 89–101; bk 8, 55.

4 Works Demos Bohn in 5 vs v 1 p 185, Oration on the Navy Boards: there are many allusions in Demosthenes' speeches to the sea.

5 In Thucydides in 429 and 427; bk 2, 83 and bk 3, 78: the other in about 50 B C; see Dio's Rome Foster ed v 3 p 208 and Lucan's Pharsalia Rowe trans bk 4 line 720.

manders afloat, "To keep all their forces employed in sailing without intermission:" When day came, so the messenger goes on, "The Greek right wing skilfully formed first led the way in order and next came all the rest of the fleet after them and we might at the same time hear them loudly shout xx. And the clamor of the Persian tongue went forth from us in answer xx and ship dashed against ship its brazen prow. At first the torrent of the Persian forces made head against the attack, but when their numerous ships were crowded [6] together in the straits xx they themselves both shattered the banks of their oars by the crash of their own brazen beaks and the Greek ships with no unskilful tactics bore down upon them encompassed in a circle. The hulls of the ships were capsized and the sea no longer could be discerned being covered with the wrecks of the ships and the slaughtered bodies of men. xx Be well assured of this that never in one day did so great a number of men perish." [7] Almost the last words in the play are, "Oh woe for them that perished in the ships with their triple banks of oars." [8]

Herodotus mentions 2 classes of vessels in telling of the Persian invasions; trieres and penteconters, 3-oar ships and those with 50 oars 25 on a side all in one level; and in Æschylus we read of only one class, "Ships with their triple banks of oars;" Diodorus the only remaining author of ancient times who tells of Salamis writes,[9] "The Athenians fiercely pursued them; some of their vessels they struck through with the beaks of their vessels and brushed off the oars of others. Many of the barbarian ships in the flight lying open with their broadsides to the beaks of the Grecian vessels by multitudes of strokes were pierced through and through so that not having time to turn they fled as well as they could with their oars reversed." [1] None of the 3 authorities gives cause to suppose the Greek and Persian ships were unlike a thing they would surely do especially the seaman Æschylus if it were the case.

Salamis brought to an end the attempts to conquer Greece, if its result had been the opposite the course of civilization must have been profoundly changed. There were 1500 trieres present in all; their total

[6] The messenger had already told Atossa the Persian fleet numbered 1000 and the Greek 300.

[7] Trieres had 200 oarsmen which would make the men in the Persian fleet over 200000.

[8] Æschylus Persians Bloomfield and Scholefield trans.

[9] Booth trans 2 vs v 1 p 375: Diodorus wrote 50 B C.

[1] This is one of the passages cited by Adm Serre to prove oarsmen turned themselves about to row backward; a thing impossible if they were at 3 levels or 3 abreast; see above p 87.

displacement was about 75000 tons and the number of men in them 300000. The bay is very small for 1500 ships: the narrow part where the Greek fleet formed is about 1 mile wide with the little island of St George occupying part of the channel and its depth is from 1 to 4 fathoms.[2] If the Greek fleet was formed in several lines abreast each ship 60 feet from those to right and left about 70 could be in one line, which gives for the 378 ships a depth of 6 lines. If the fleet could pass injured vessels to its rear it would have great advantage over crowded and unorganized ships.

HERODOTUS' DESCRIPTION OF COUNCILS HELD BY SHIP-CAPTAINS BEFORE SALAMIS.

Before Salamis when the Greek and Persian fleets were off Athens a discussion arose among the Greeks as to where they should fight. The story may be pieced together: ships of all Greek states were in the fleet those of Athens being the most numerous and after the Pass of Thermopylæ was lost it was hoped progress of the Persians might be arrested at the Isthmus of Corinth, 30 miles west from Athens and 10 miles wide, which would save Sparta and the states south from devastation, Athens and the surrounding country being already in the hands of the enemy. The citizens of Athens were however not ready to abandon hope and wished the fleet to remain in Salamis Bay and fight there. Those who deemed it best to withdraw towards the Isthmus expected the fleet to go with the army for ships were necessary to any plan: the numerous vessels of Athens gave weight to that city in councils held but Sparta had the larger army and fighting on land at the Isthmus would be largely by Spartans as had been the case at Thermopylæ.

Herodotus' story of this difference among the Greeks adds to knowledge of ships and their ways: he says as to the discussion,[3] "The admiral was the same who had commanded before to wit Eurybiades xx who was a Spartan. The city however which sent by far the greatest number of ships and the best sailors was Athens. xx The whole number of ships not counting the penteconters was 378. When the captains from these various nations were come together at Salamis a council of war was

[2] Maps will be found in Bury's Greece and Grundy's Great Persian War. In Grundy's book pub 1901 is a desc of the battle in the light of modern information; p 384 are plans showing successive positions of ships. See v 1 p 112 Du Sein, Hist de la Mar de Tous les Peuples for a plan and copy Æschylus' play. The last work includes diagrams of fleet-actions until our day.

[3] Bk 8, 42–63.

summoned and Eurybiades xx said Attica was not to be thought of now. The speakers mostly advised that the fleet should sail away to the Isthmus of Corinth. xx As the captains from the Peloponnese were thus advising there came an Athenian to the camp who brought word that the barbarians had entered Attica and were ravaging and burning everything xx. A few people xx fortified the citadel with planks and boards xx; they imagined themselves to have discovered the true meaning of the oracle uttered by the Pythoness which promised that, 'The wooden wall should never be taken' xx: the wooden wall they thought did not mean the ships but the place where they had taken refuge. xx At Salamis xx they fell into such alarm that some of the captains did not even wait for the council to come to a vote but embarked hastily xx and hoisted sail as though they would take flight immediately. The rest who stayed at the council board came to a vote that the fleet should give battle at the Isthmus of Corinth. Night now drew on and the captains dispersing from the meeting proceeded onboard their respective ships. Themistocles as he entered his own ship was met by Mnesiphilis an Athenian."

This man tells Themistocles if the fleet stands away for the Isthmus of Corinth each ship will return to her own home leaving Sparta the country of Eurybiades uncovered. Themistocles took the hint and, "Went straight to the vessel of Eurybiades. xx Eurybiades bade him come onboard and say whatever he wished. Then Themistocles seating himself at his side went over all the arguments he had heard from Mnesiphilis xx until at last he persuaded Eurybiades by his importunity to quit his ship and again collect the captains to council. As soon as they were come and before Eurybiades had opened his purpose in assembling them together xx;" Themistocles tells the council unless they agree to fight the Persians where they are the ships of Athens will withdraw take their families onboard and go to Siris in Italy which is theirs from of old. Eurybiades seeing the peril of Sparta, "Decided to remain and give battle at Salamis. And now the different chiefs notwithstanding their skirmish of words on learning the decision of Eurybiades at once made ready for the fight."

This is much as it might be now. The councils are held onshore and the captains come and go in small boats as they would do now. Even now it might be hard to find room onboard ship for a council of 378 captains; the number of ships not counting penteconters. It is a pity we do not know what Themistocles and Eurybiades had for a seat onboard ship. The

ships were anchored off from shore yet it is only 10 years after Marathon where the victorious Greeks, "Hung upon the runaways xx chasing them all the way to the shore on reaching which they laid hold of the ships xx." The difference admits of explanation; with sterns touching the beach at Marathon were 600 Persian trieres [4] the place being selected because of a clean sand beach of the length necessary to accommodate them,—about 5 miles. At Salamis it was otherwise; neither fleet was beached, partly because the enemy was near and partly because there was at the point no suitable beach. Frail long-ships could not use a steep shore or one foul with rocks.

OTHER STATEMENTS OF HERODOTUS.

There are statements made by Herodotus respecting the Persians which are picturesque and interesting. During Salamis Xerxes sat on a throne at the foot of a hill called Ægalos, opposite Salamis about a half-mile from the north-east end of the original Greek line, and when he saw a ship perform a worthy exploit he had the name of her captain taken down by his scribes together with that of his father and city. The ships were known by scrolls at bow and stern called respectively *acrostolos* and *aplaston*.[5] It was upon seeing the gallantry of Artemisia's ship that Xerxes exclaimed, "My men behave like women and my women like men." The King had in like manner watched the head of his army wither as it reached the hand-full of Greeks under Leonidas in the Pass of Thermopylæ: "During these assaults," writes Herodotus, "it is said that Xerxes who was watching the battle thrice leaped from the throne whereon he sate in terror for his army." [6]

ANCIENT AND MODERN WAR COMPARED.

Nowhere is formal mention of how far apart ships were when formed for battle or the distance between fleets before the charge.[7] The former

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[4] Above p 119; as to beaching ships note the Mediterranean is almost tideless and current-less.

[5] Cartault Tr Athen p 82; Serre Mar de Guerre v 2 pp 182, 197: Polyænus Strat of War Shepherd trans pp 353–4, "Artemisia in the Battle of Salamis finding the Persians defeated and herself near falling into the hands of the Greeks ordered the Persian mark to be taken down xx. She always carried with her Grecian as well Barbarian marks:" Polyænus' date is 125 A D.

[6] Bk 7, 212: he writes also, "Among all this multitude of men there was not one who for beauty and stature deserved more than Xerxes himself to wield so vast a power."

[7] Above p 99, below p 174.

was perhaps 60 to 80 feet of open water between the ends of oars of ships. From out to out over the ends of oars of a triere of the Persian Wars was about 60 feet; considering fleets not infrequently numbered 200 the difficulty of keeping station was great for the length of fleets in line or column was often 4 miles. The distance between fleets in line abreast ready to charge was greater than the range of missile-arms and enough to let ships reach speed and steer steady; perhaps 1500 yards.

Thucydides tells of Sybota 432 B C that ships used missile-arms while approaching and fought hand-to-hand and by boarding on contact, writing,[8] " As soon as the signals on each side were raised they closed and fought both sides having many heavy-armed on the decks and many bowmen and dart-men as they were still rudely equipped in the old fashion. And the battle was xx like a land fight. For whenever they ran aboard of one another they did not easily get clear again owing to the numbers and confusion of the ships and because they trusted for victory in a great measure to the heavy-armed on deck who set-to and fought while the ships remained stationary. There was no breaking through the line but they fought with fierceness and strength more than with science." [9] There were 150 ships in one fleet and 120 in the other and the length of each in single line or column was nearly 3 miles. The ships had 200 oarsmen; so each fleet mustered 20 to 30 thousand men and these the night before the battle slept in tents onshore, the encampments being 8 miles apart. Thucydides tells in the place cited in second note above that a squadron landed during the battle to plunder the enemy's encampment and burn the tents. Tents were carried in ships and landed before engagements as well as the heavier masts and sails; but they were necessary, for the men could not live many days continuously in the ships. These were 125 feet long and 15 beam: the area of the water-line was less than 1875 square feet; which allowing 5 feet by 2½ for each man gives space for 150 to lie down; 50 less than the complement.

The bulk of these fleets were ships of Corcyra and Corinth, the battle occurred near Sybota on the west coast of Greece and the year 432 B C was the one before the Peloponnesian War began.[1] With the fleet of Corcyra were a few Athenian ships and Thucydides says the Corinthians, " Were afraid of the charge given by the Athenians: " perhaps Athenian

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8 Bk 1, 49–54.

9 Below pp 161 and 171.

1 From Thuc with plate 24 Smith Atlas Anc Geog the engagement can be followed.

ships could turn quickly and ram astern or better care for their oars. Possibly but not probably they had strengthened their prows against damage in meeting the enemy as Syracusan ships did 15 years later when expecting encounters with Athenian ships,[2] or perhaps Athenian ships had sunk their spurs below the level of the water so as to strike a more deadly blow. Of these the first is most likely; that Athenian ships turned quickly and cared for their oars. There is another important statement of Thucydides regarding this battle; " The Corinthians rowed stern-ward and retreated." This has been intrepreted to mean oarsmen were so placed they could turn about to back.[3]

BATTLE FORMATIONS IN ANCIENT AND MODERN DAYS.

Fleets usually formed in one line abreast with prow toward the enemy but at Arginusæ 406 B C the Athenian fleet was several lines deep while the enemy, Lacedæmonians, were in one long line and desirous of surrounding the enemy on both flanks and reaching his rear.[4] Admirals have always been careful not to be outflanked.[5] This was shown in Graves' action with the French off Chesapeake Bay in 1781.[6] The desire to make equal the fighting front of fleets has given rise to plans of curious character. Admiral Rooke a British officer of experience wrote in 1700 regarding prospective reinforcement of his fleet by Swedish ships, " If we were joined we can't all engage together we shall out-line them so much." [7] The unfortunate Byng in his action with the French off Minorca in 1756 took a ship out of his line so he might have the same number as the enemy: Campbell writes, " Admiral Byng before the engagement ordered the Deptford to quit the line in order to reduce his line-of-battle to the same number of ships as that of the enemy. For this apparent generosity he was censured by the court-martial, nevertheless there does not appear to be any great impropriety in removing one or more supernumerary ships in readiness to supply the place of those which may happen to be disabled." [8]

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[2] Below p 145.

[3] Above p 87.

[4] Xenophon Hell bk 1, 6, 25.

[5] See Hoste Art Armées Navales 1697; Fighting Instr 1530–1816 Navy Rec Soc (English) pp 179–82.

[6] Letters Hood Navy Rec Soc pp 31–47.

[7] Rooke's Journal Navy Rec Soc p 62.

[8] Lives of Adms v 5 p 6.

THE GREEK BATTLE-SIGNAL-BOOK.

Ordinary signal-books contain great number of words phrases and messages as well as the letters of the alphabet and signals are made by from 1 to 4 flags, but battles call for few signals and these are made by a single flag or sign. In Greek writings the words *diekplous periplous* and *anastrophe* occur; the first meaning a sailing through the second a sailing around and the third a turning back or about a return.[9] The words were on the first page of the Greek Battle-Signal-Book if as is probable there was one.[1] Cutting the line was familiar before the beginning of history: Sophocles born about 500 B C wrote,[2] "All the western end of the fleet has been cut;" Herodotus 20 years later says the diekplous was oft-times practised at Lade 496; and in later day Thucydides Xenophon Diodorus and a number of others mention the 3 evolutions. Polybius a careful and esteemed writer born 204 B C explains evolutions in detail in describing the Battle of Chios between fleets of Macedonia and Pergamos in 201 B C, writing,[3] "The most frequent manœuvre was to row through the Macedonian line and disable the ships by breaking off their oars and then rowing round into position again charge on the stern or catch them on the broadside as they were in the act of turning, and thus they either stove them in or broke away some necessary part of their rigging." This is so neat and complete we might believe Polybius a theorist, but he commanded a fleet at sea and his descriptions during the Punic Wars are the same.

After Polybius we must go on to 56 B C before reading of these evolutions again. In that year diekplous and periplous were executed by long-ships against round-ships unprepared to fight; the Roman general Brutus commanded the long-ships and the round-ships belonged to the Veneti, the people of Brittany, then and now a race of unsurpassed seamen: Brutus we are told,[4] "With swift ships from the Mediterranean" when the fleet of the Veneti lay becalmed, "Used both periplous and

9 They will be found in Greek dictionaries; fuller account of their meaning written by men who commanded in battle are in Thucydides 1, 49; 2, 89; 7, 34, 36, 38, 40, 67; Xenophon Hell 1, 6, 31; Polybius 1, 51; 14, 10; 16, 3, 4.

1 P 117 n 1 above for battle plans.

2 Trans Bohn 1849 play Ajax p 267: see also pp 276, 280, 291 for interesting passages.

3 Shuckburgh trans 1889 bk 16, 2–8: Serre Mar de Guerre v 1 pp 119–34 has exhaustive exam of Polybius' description. See p 161 below for description by Livy similar to Polybius.

4 Dio's Rome Foster ed v 2 p 185; Cæsar's Comm Gallic War 3, 11; p 71 Bell ed. Dio says the Veneti, "Live in the Ocean," that their sails were of leather and ships without oars.

diekplous, now ramming one of them now backing water in whatever way and as much as he liked. xx Some he sank by ripping them open and others he boarded from all sides with his heavy-armed. xx The barbarians did not use archery and had not provided themselves before-hand with stones xx and grieved terribly at being betrayed by the stationary qualities of their vessels." Dio wrote in 200 A D; thus we have written account of diekplous and periplous from 500 B C to 200 A D.

THE LATER HISTORY OF THE DIEKPLOUS.

From the day of Dio we do not read of Passing Through the Line until Pere Hoste wrote his Traité des Evolutions Navales in 1697. The evolution was practised in the wars of the Dutch with Spain not long subsequent to 1600 and in the English-Dutch wars 60 years later. Hoste had been at sea with more than one of the French admirals of his day; he does not say the manœuvre was invented or brought out in his time but writes of it as familiar reflecting no doubt the view of seamen of his day: "It is," he says,[5] "a manœuvre as bold as it is delicate." Then 100 years after the Dutch wars Rodney passed through the French line in the West Indies and people began to wonder who invented the manœuvre. It was invented in pre-historic days by some person unknown, and we have allusions to it for 700 years after and then hear nothing of it; but admirals kept it ever in mind for if well-judged and successful it must result in victory.

The manœuvre is elusive for if one fleet is cut or passed through the other is also. Sir Gilbert Blane surgeon onboard Rodney's ship Formidable when she went through the French line shows much acumen in describing it: the advantage does not lie in the closeness of the ships which is mutual and equal this gentleman writes; adding,[6] "The Formidable passed so near the Glorieux I could see the gunners throwing away their sponges and land-spikes in order to save themselves by running below while our guns were served with the utmost animation." I venture an explanation of the unsteadiness of the French seamen if indeed they were unsteady. When the Formidable went through the manœuvre had not been prescribed to the English ships, and it has been said she went through by accident and in consequence of a flaw of wind as she reached the French line. Rodney had ordered his ships to go through when preparing for an earlier battle

[5] For discussion see pp 182–4 Fighting Ins 1530–1816 Nav Rec Soc Publ; also pp 179–85 same v.

[6] Blane's letter v 2 p 228 Mundy's Rodney.

but on this occasion had not ordered it and only his ship went through. If the English gunners knew the manœuvre might be executed while those in French ships were ignorant of this it is sufficient explanation of the conduct of the former being better than the latter, for nothing is so disconcerting in moments of excitement as the unexpected. If French officers neglected to prepare their men although as Hoste shows their ships executed the manœuvre 100 years earlier they were to blame.

At a time when the morale of French navy had been broken by the Revolution Howe in the Battle of the First of June 1794 and Nelson at Trafalgar ordered their ships to pass through the enemy's fleet. The ships of both commanders went through and were in great consequent peril; in Howe's fleet a few other ships went through and at Trafalgar 11 years later more. The ensign of the Victory Nelson's ship swept the mizzen rigging of the Bucentaure the ship of the French commander-in-chief as she went through, being forced to close by the Redoubtable, the next-astern to the Bucentaure, closing to prevent her going through. Nothing could be more gallant than the conduct of all at this point and the Victory narrowly escaped capture by boarding.[7] Howe's fleet before attacking was in single close-hauled line head and stern parallel to the French; at a signal the ships put their helms up together and ran down still in one line parallel to the French each ship to pass through the interval opposite it. Nelson's fleet came down before the wind in 2 lines ahead, the allied French and Spanish fleet being in a single close-hauled line head and stern: Nelson's ship the Victory led one line and Collingwood's the Royal Sovereign the other. Admiral de la Gravière, a French officer of recent day writes,[8] "The internal weakness of our navy was the justification for the imprudences of Nelson." Our navy has employed the diekplous for Perry practised it at Lake Erie. It may be seen again but not between equal and uninjured fleets.

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7 Howe's and Nelson's orders are clear; very few of Howe's ships went through and Nelson's plan was not understood by all: Captain Codrington who commanded a ship wrote of the action, "We all scrambled into battle as soon as we could:" Fighting Instr Navy Rec pp 282–313.

8 Siege de Rochelle p 397. The geometrical arrangements of the fleets at Trafalgar and Tsu-shima were the same; at the last the Japanese fleet occupied the position of the vanquished at Trafalgar.

CHAPTER IV.

LONG-SHIPS.

Wars of Greece after Those with Persia;
Wars of Rome until the Christian Era. Fitting Manning and Operating Ships;
Inability of Long-Ships to Keep the Sea.

The hulls and large spars of Greek war-ships were provided by government while private citizens furnished light spars sails oars and stores. Citizens who undertook this were exempt from certain other obligations; they were called *trierarchs* and went in the ships in person or by deputy and commanded them being assisted by seamen when without experience. They paid the crews *sitos* money with which to buy food onshore [9] for long-ships carried no general supply of food though the men at times took onboard enough for a few meals. The plan of sending into battle ships owned by their commanders lasted through ancient and mediæval days; as late as 1700 A D we read of ships of Holland and England being backward in fight because their commanders feared government might not repair damage done them.[1]

Oarsmen in ancient day were free and paid for their services though slaves were forced to the oar and freemen were not infrequently impressed. Seamen were of the social class the Greeks called *thetes* inferior to the cavalry and heavy-armed. The heavy-armed were called *epibatai* and oarsmen and seamen *nautai* and among the last were some who did not take an oar but tended anchors cables and sails kept the look-out steered and did similar work. The heavy-armed epibatai were distinct from the nautai; they were soldiers, wore armor carried swords javelins and shields, and were stationed and lived on the upper deck, the *catastroma,* where they engaged the enemy or boarded him when the ships were brought into contact. The *thetes* voted in the assembly and as they were numerous were able to assert themselves. Three contemporary authors have left state-

[9] Below p 134 as to *sitos* money. The word *trierarchos* means captain of a triere.

[1] Pp 117–21 Gravière Gueux de Mar will be found Holland's methods of maintaining her navy when fighting the Spanish.

ments showing the political power of seamen in Athens;[2] (1) " In Athens the poor and the people in general have more influence than the noble and rich and this is just because it is the people who row the vessels and assure the power of the Republic. It is the steersmen *keleustes pentekontarchs proreus* and carpenters who have made the city much more than the heavy-armed and nobles:" (2) "I shall not be contradicted when I say that the past and present prosperity of the city and its misfortunes come from the possession or want of trieres:" (3) "It is the people who man the fleet and put around the city her girdle of power."

It is necessary to realize how little long-ships were sea-keeping. Life in them for more than a short period could not be endured. They did the fighting and were fast passenger and mail ships, but when a crew drove one far they would be worn out and for long voyages round-ships were used, going directly across the sea and often many days out. These carried abundant food and water cooked onboard and had private cabins for those who could pay. Long-ships made runs of a day or a few hours, rarely failing to land for sleep and meals. Thucydides writes in 2 places only of food carried in long-ships; in one they have food for 3 days and the other for 2[3] and the food is already cooked when put onboard. In the first of these cases the fleet is about to put to see to meet the enemy, known to be only a few miles away and the food is to be eaten onboard ship; in the second after sailing with cooked victuals for 2 days the crews are landed at 3 different places for the 3 following meals. There is as far as I can recollect only one passage in the ancient authors which indicates a probability of cooking in long-ships while there are scores regarding landing to cook. The one case is in Cæsar's Commentaries and concerns the fleet of Bibulus when opposing Cæsar's crossing the Adriatic from Italy in the winter of 48 B C; it is as follows;[4] "Bibulus lay with his fleet at Oricum and as he debarred Cæsar of the liberty of the seas and harbors so he was deprived of all intercourse with the country by land for the whole shore was occupied by parties disposed in different places by Cæsar. And Bibulus was not allowed to get either wood or water and it once happened

[2] The first two are from Aristotle and Demosthenes who were co-temporaries 384–322 B C; the words given are from Cartault's Triere Athen pp xxi, xxii: the third is in Xenophon's Polity of Athenians, 1, 1, 2; Xenophon lived 100 years before Aristotle and Demosthenes.

[3] Bks 1, 48; 8, 101. See Livy 37, 24, a Rhodian fleet in 190 B C, "Halted in the open sea and refreshed themselves with food."

[4] Civil War 3, 14–18; pp 325–7 Bell ed 1908. The blockade is maintained in winter; Cæsar is telling the story and refers to himself by his own name.

that meeting with violent storms they were forced to catch the dew by night which fell on the hides that covered their decks. Yet all these difficulties were borne patiently and without repining, they thought they ought not to leave the shore and harbors free from blockade xx. Bibulus being prevented from landing for several days and being seized with a violent distemper from the cold and fatigue, as he could neither be cured onboard nor was willing to desert the charge which he had taken upon him, was unable to bear up against the violence of the disease."

It is not expressly stated, but this shows cooking was possible: we have mentions in about 1600 and 1650 of prohibitions to cook in ships and to smoke tobacco elsewhere than over a tub of water.[5] Upon the death of Bibulus several succeeded to the command and the blockade was held through the winter. In the same part of the Commentaries Cæsar writes that a squadron of 50 from the enemy's blockading fleet crossed the Adriatic to Brundusium where Cæsar's transports and war-ships were lying and, "Seized an island which lies opposite to that harbor, judging it better to guard that place which was our only pass to the sea than to keep all the eastern shore of the Adriatic and its harbors blocked up by a fleet." This rule of war is in the books still. The fleet was however debarred by shore-positions held by Cæsar on both sides of the Adriatic from communicating with the land and by this was reduced to impotence for Cæsar's army crossed successfully although his sea-force was materially less than that of the enemy.

THE PAY OF GREEK AND ROMAN SEAMEN.

Long-ships carried little food or water and pilots were obliged to know where water could be found so that the men might land to replenish. Food the men bought in markets onshore with the *sitos* or *siteresion* money paid each by his trierarch. Men received also *misthos* money; this was pay proper and when clothing and arms were paid for, both provided by the men themselves, could be used as desired.[6]

HOW THE FLEET SENT AGAINST SYRACUSE BY ATHENS IN 415 B C WAS PROVISIONED.

The plan of paying men is not unlike the one now usual in navies, a ration of food issued having taken the place of sitos-money. At times as when

[5] Below pp 296, 310; also p 523, none may smoke in galleys in 1700 but may in boat towed astern.

[6] Boeck Pub Econ Athenians Lewis trans 2d ed p 272: Works Demosthenes Bohn 5 vs v 5 p 130; Ort Against Polycles.

coast towns might prove unfriendly round-ships accompanied war-fleets and carried food and cooked: when the Athenian fleet went to Syracuse in 415 B C Nicias its commander told the Assembly in Athens,[7] "We take our corn from home also in round-ships; namely wheat and parched barley with bakers from the mills compelled xx to serve for pay, that should we anywhere be detained by stress of weather the force may have provisions, for so numerous as it is it is not one for every city to receive." It is impossible to determine how many ships and men this expedition comprised or how long it was going to Syracuse, but is a fair deduction from Thucydides that the voyage took 3 months. As to ships and men a number of squadrons met at Corcyra before crossing to Italy, some 350 to 400 sail; Thucydides says there were 134 trieres, whose crews would number 27000, and there may have been a total of 500 sail with 50000 men. Only large towns could receive so many and furnish food for the sitos-money. Some towns in Italy refused admission within their walls and to sell food through fear of the Syracusans, others fearing to admit so many armed men set up markets outside their walls. The fleet was divided at Corcyra in order that cities might be better able to furnish food but the round-ships with the fleet having bakers onboard were at times the only source of supply. Round-ships were never in difficulty as to food and water, but the manner in which they were equipped and their men paid we do not know for historians have not written much of them.

COSTS OF WAR-FLEETS.

The costs of ancient war-fleets may be stated. The food required in a month by the 200 men in a triere cost about $360 of our money; this would be sitos-money provided by the trierarch; and the pay proper for the same number of men misthos-money would be about the same.[8] Thus the cost per month to pay and provision 100 trieres would be $72000, a very large sum in the day. Thucydides writes as to the year 427 B C 4 years after the Peloponnesian War began,[9] "At the time xx they had about the largest number of ships they had ever possessed at once in effective and fine condition xx. A hundred kept guard around Attica Eubœa and Salamis while another 100 were cruising about the Peloponnese beside those at Potidæa and in other places, so that altogether there were 250

[7] Thuc 6, 22, 44; see below p 198; above p 113 n 3 as to speeches found in ancient authors.

[8] Boeck Pub Econ Athens Eng trans p 275.

[9] Bk 3, 17.

in service in the course of that one summer." It would require 50000 to man these and maintenance for 6 months would total $1000000. Boeck puts the cost of constructing and fortifying the docks at the Piræus where the war-fleet could lie under cover at $1000000 and that of the bare hull of a triere at $1200.[1] It may be noted the 50000 men Athens maintained afloat in 250 trieres in the summer of 427 B C come to the same total as the crews of 50 battle-ships of our day. The displacement of one modern battle-ship is several times that of a fleet of 250 trieres and the cost of building her exceeds that of the trieres in greater ratio: the hull of a triere cost $1200 so 250 cost $300000. A striking change is that in tons of ship's displacement per man carried: if we take the conclusion of Admiral Serre there was in a triere of the Peloponnesian War $^3/_5$ ton displacement per man while in modern war-ships there may be 50 tons per man. The ratio between these numbers is a fair measure of the comfort of people in ships of the periods.

THE OFFICERS OF GREEK SHIPS.

Next inferior to trierarch in Greek long-ships was the *keleustes*. He managed the rowers and had 2 subordinates called *toicharchoi;* [2] one commanded oarsmen on the starboard side and the other those on the port side, and the starboard side of the vessel was preferred for the toicharchos on that side was the leader in joint operations.[3] This rule held in mediæval days and still prevails: Pantero Pantera, writing in 1615 A D of Italian galleys, says they had 2 *spallieri*: "The better man being to the right," he says,[4] "the other to the left and they set the time of the stroke, this being the secret of the good progress of the galley." There was also in Greek long-ships a *trieraules*, flute-player, to cheer the men at the oar. There were *prorates* or *proreus* whose station was at the *prora* or bow, who from thence directed the steering. The steersmen were called *prumnetes*, their place being at the *prumna* or stern. Round-ships were com-

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[1] Pub Econ Athens pp 201, 108.

[2] The Greek word for rower in a general sense is *eretes:* Greek writers mention 3 classes of rowers, *thranites zygites thalamites:* Serre Mar de Guerre v 1 p 19 says "Nowhere are mentioned other than tranite zygite and thalamite oars and oarsmen;" see cross-section of triere at end this v Serre as to probable origin of these terms. The first pulled the upper the second the middle and the thalamite the lowest line of oars.

[3] Cartault Triere Athen p 167. Pp 224–39 Cartault will be found on titles and duties of officers in Greek ships: see Demosthenes Or agt Polycles cited note 6 p 134 above.

[4] A quote from Pantera's Armata Navale in Wiel's Navy of Venice.

manded by a *naukleros* who was often owner as well as master of the vessel.[5]

THE COMMANDERS OF FLEETS.

The commander of a Spartan war-fleet was called *navarch*, commander of ships; but the Athenians who depended more on the sea and whose fleet was larger than that of any other Greek state called an admiral *strategos*, the name of the commander of a land army: Greek states chose these officers by vote of the assembly of the people and for a stated time only and there were often several commanders in fleets whose relations to one another were not defined. This very bad plan was long followed and seems to have been more steadily pursued in Athens than other states. Pericles Themistocles Epaminondas Scipio Africanus Hannibal[6] the two Pompeys Polybius Thucydides Pausanias Augustus Cæsar Agrippa Antony Cicero Pliny, all commanded fleets.

Later continuing until war-fleets consisted of sailing-ships when only professional seamen are found in ships[7] men of all classes, the great soldier Belisarius reigning sovereigns princes of the blood, doges of Venice Genoa and Pisa, authors who achieved immortal fame—Cervantes and Marco Polo, are found commanding fleets and ships. Of all none are more interesting than the Zeno and Dandolo families of Venice and Vivaldi and Doria of Genoa. The men of no house have remained longer in the sea-force than the Doria. Lamba Doria with 6 sons fought in the fleet of Genoa at the Battle of Meloria in 1284; Andrea Doria commanded in chief at Previsa 1538; and many others of the house held important commands in the fleets of Genoa.[8]

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[5] In the operation of round-ships bottomry bonds the oldest form of insurance came into being; in Demos Or agt Polycles cited note 2nd above negotiating one at 12½ per cent. is narrated: see also Parson's Rhodian Law; Ashburner's Rhodian Sea Law; Boucher's Consulat de la Mar; Pardessus' Collection; Boeck Pub Econ Athens.

[6] Booth's Diodorus v 2 p 61; see also Justin Nepos and Eutropius Bohn pp 423, 425, 477; Mommsen in his Hist Rome refers to Hannibal's command afloat. The authority as to Epaminondas and Hannibal is given because it is not generally known they commanded at sea.

[7] There are not a few exceptions: the famous Admiral Blake and others of Cromwell's day went to sea first when middle-aged; the Dutch Admiral Heemskerk was not a seaman; and French admirals in command during our Revolutionary War were not all bred at sea.

[8] See word Doria Larousse Encyc; Doria et Barberousse Gravière; Doria Petit; Barbarossa (commanded fleets opposed to Doria) Blackwood's Mag 1842 v 52; Deux Pirates au 16 ieme Siecle, Farine. Andrea Doria and Barbarossa are among the few seamen who have wielded imperial power.

EVENTS FOLLOWING THE BATTLE OF SALAMIS: THE CONFEDERACY OF DELOS.

The year after Salamis the army left when Xerxes fled back to Persia was destroyed by the Greeks under Pausanias at Platæa and on the same day a Greek fleet defeated a Persian one at Mycale,[9] that is within sight of the Island of Lade where Greek and Persian fleets had met 17 years before. The victorious Greeks followed the Persians east and until the day of Alexander the Great warred almost continuously with them.

The Greeks at Mycale were commanded by Leotychides and 300 Persian battle-ships were destroyed and the force dispersed, "The Hellespont and the islands formed the prize," writes Herodotus.[1] That is the prize was the grain of the Black Sea and control of islands near the west coast of Asia Minor. Leotychides was supplanted in command the year after he won Mycale by Pausanias who had won Platæa; he took the fleet to Cyprus and after successes there to Byzantium. Here the agreement among the Greeks intended to consolidate resistance to Persia called the Confederacy of Delos was debated and executed. Thucydides writes,[2] "Pausanias was sent out from Lacedæmonia as navarch of the Greeks with 20 ships from the Peloponnese; there sailed with him also the Athenians with 30 ships and a large number of the other allies. They made an expedition against Cyprus and subdued the greater part of it and afterwards against Byzantium of which the Persians were in possession and reduced it during this period of his command. But when Pausanias was now acting with violence the rest of the Greeks in the fleet were offended xx and going to the Athenians begged them to become their leaders xx. The Athenians received their proposals and attended to them xx. At this time the Lacedæmonians sent for Pausanias to bring him to account for what they had heard of him xx. Him they sent out no more as commander but Dorcis and some others with him, xx but the allies would no longer give up the command to them. xx The Athenians having in this way succeeded to the command at the wish of the allies xx arranged which of the states were to furnish money against the Persian and which of them ships xx. The office of Treasurer-of-Greece was then first established by the Athenians who received the tribute, for so the contribution-money was called. The

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9 The date is Sept 22, 479: Herodotus describes Mycale bk 9, 90–106.

1 Bk 9, 101.

2 Bk 1, 94–6: the year was 478. Pausanias and Leotychides were Lacedæmonians Spartans; the greater power of Sparta on land put her in the front at sea in spite of Athens' greater number of ships.

first tribute that was fixed was 460 talents.[3] Their treasury was at Delos and their meetings were held in the temple."

The Confederacy of Delos was born of operations at sea formulated in the fleet at Byzantium and probably executed in ships. It led to the power and glory of Athens and in 50 years to the fratricidal contest known as the Peloponnesian War. Thucydides tells as to the course of the various states,[4] " The greater part to avoid being away from home agreed to contribute money instead of ships as their quota and thus the fleet of Athens was increased by the funds which they contributed while they themselves whenever they revolted found themselves unprepared and inexperienced for war." Several states, particularly those of the Peloponnesian Isthmus, barren and arid and without egress by land except by the narrow Isthmus of Corinth, became alarmed at the control acquired by Athens of over-sea food supply and in 431 the Peloponnesian War broke out being preceded by an act indicative of the arrogance of Athens; removal of the Treasury from the Island of Delos to their city in 461.[5]

THE PELOPONNESIAN WAR.

Only so much of wars will be noticed as helps to show what ships and sea-ways were like, though scientific examination of the operations of war lies near to hand. No war was more purely on the sea than the Peloponnesian and yet its history from that point has not been put together: so much indeed did everything in ancient day depend on the sea that the history of Greece and Rome cannot be understood without close attention to sea affairs: a modern student writes, " Among the researches having in view the reconstruction of the ancient Greeks none reach their character and life more nearly than affairs of the sea. The Hellenes were before all seamen and it is in this point of view that those who desire to understand their history and fate must place themselves." [6]

The Peloponnesian War began 431 B C and was ended by annihilation of the fleet of Athens in 405 at Ægospotamos in the Hellespont. Athens led the states she could hold to alliance and Sparta those opposed, the

[3] The talent was about $1200; if payment was annual Athens could defray the cost of a fleet of 125 trieres with it: see above p 135.

[4] Bk 1, 99.

[5] Regarding Greek food supplies see Grundy's Thucydides Economic Background and Approvisionnement d'Athenes en Ble Gernet 1909 in Melanges d'Hist Ancienne XXV.

[6] Cartault Tr Athenienne p 1.

power of Athens being on the sea and of Sparta on land. The peninsula of Attica whence alone Athens drew a home-supply of food was over-run and the crops destroyed again and again by armies, but protected by her Long Walls which enclosed Athens and her 2 sea-ports Peiræus and Munychia in a fortified triangle she lived on supplies brought by ship paying with manufactures and ocean-freights. Thucydides a participant in the war begins [7] his history, " Thucydides an Athenian wrote the history of the war between the Peloponnesians and the Athenians how they warred against each other, having begun from its very outset with the expectation that it would prove a great one xx." The soil of Greece is poor and throughout the war Athens sought to control sea-routes. Food-ships came from the north and east through the Hellespont; from the north-west where lay the grain fields of Sicily; and by 2 routes from the south. Sparta lying in the extreme south of the Peloponnese could be starved by closing the last 2. One of these went past the Island of Cythera within sight to the south from the south of Sparta thence south to Africa and thence along the north shore of Africa to Egypt; the other east across the Ægean to the S W corner of Asia Minor and thence south to Egypt. Athens sought to stop her enemy's food-ships and brought about in 421 after 10 years' fighting the Peace of Nicias by the terms of which her sea-power was held unimpaired.

THE TEN YEARS' WAR.

This first part of the Peloponnesian War is called the Ten Years' War 431–421 B C. Its first battle to be noted was fought by the Athenian admiral Phormio with 20 ships at the mouth of the Gulf of Corinth. The enemy formed radially with bows outward; Phormio, " Hoped that their order would not be maintained like that of a land force onshore xx. The Athenians ranged in a single line kept sailing round them and reducing them into a smaller compass, continually brushing past them and making demonstrations of an immediate onset, though they had been previously commanded by Phormio not to attack till he himself gave the signal. He hoped xx the ships would fall foul of each other and if the wind should blow xx they would not remain steady an instant. So when the wind came xx ship was falling foul of ship and the crews were pushing them off with poles and in their shouting and trying to keep clear and abusing each

[7] Bk 1, 93; Grundy's Thuc as to Long Walls, begun 458 B C. Large scale drawings of Athens' ports and walls are in Smith's Atl Anc Geog pl 25.

other did not hear a word either of orders or directions xx; just then at that favorable moment Phormio gave the signal. And the Athenians attacked them and first of all sunk one of the admiral-ships then destroyed all wherever they went and reduced them to such condition xx they fled. The Athenians closely pursued and took 12 ships picking up most of the men from them and putting them onboard their own vessels; xx after erecting a trophy at Rhium and dedicating a ship to Neptune they returned to Naupactus."

Phormio was soon again in presence of the enemy. His ships were the 20 he had before; the enemy Peloponnesians as before now mustered 77. Thucydides writes,[8] "For 6 or 7 days they lay opposite to each other practising and preparing for battle xx, the distance between the 2 anchorages being about 7 *stades* of sea which forms the mouth of the Crisæan Gulf." The fleets were a mile [9] apart and though Thucydides says nothing of it had tents onshore, for it is most unlikely the men remained in the ships anchored off and practised rowing and fleet evolutions many days. Thucydides proceeds with Phormio's speech the men being onshore, "Phormio being alarmed at the apprehensions of his men and perceiving that they formed in groups amongst themselves xx wished to assemble and cheer them xx. He therefore called them together and addressed them as follows: 'Seeing you my men alarmed at the numbers of your opponents I have called you together xx. The fact on which these men chiefly rely in coming against us is because they are generally successful owing to experience in land-service and they think it will do the same for them at sea. But this in all reason will rather be our advantage now xx from our being more experienced in this particular service xx. As for the battle I will not if I can help fight it in the strait, being aware that for a few skilfully managed and fast vessels against a larger number unskilfully managed want of sea-room is a disadvantage. For one could neither sail up as he ought to the charge without having a view of the enemy from a distance nor retire at the proper time if hard pressed; and there is no breaking through the line nor returning to a second charge—which are the

[8] Bk 2, 86–92. Many fleet actions occurred here-about: Phormio's battles were near the contraction in the west end of the Gulf of Corinth; Lepanto 1571 A D was 35 miles further north. The Gulf of Arta with the town of Actium at its entrance is 50 miles north of Cape Skropa, which forms the north side of the entrance to the Gulf of Corinth: here were fought a first Actium 435 B C, Sybota 432; the famous Actium 31 B C; Previsa 1538 A D.

[9] The entrance is one mile wide by modern maps.

manœuvres of the better-sailing vessels—but the sea-fight must in that case become a land-fight, and then the greater number of ships gain the superiority. xx Do you remaining in good order in your ships be quick in receiving the word of command especially as our post of observation is at so short a distance, and during the action attach the greatest importance to order and silence which is of service for operations of war in general and for a naval engagement more particularly.[1] xx Great indeed is the struggle in which you are engaged either to destroy the hope of the Peloponnesians as regards their navy or to bring nearer home to the Athenians apprehensions for the command of the sea.' "

Few will differ from Phormio; he was however drawn into the contracted space within the Gulf by the enemy entering it and threatening a city friendly to Athens: Thucydides writes, "When Phormio saw the enemy underway against his will and in great haste too he embarked his crews and sailed along the shore. When the Peloponnesians saw them coasting along in a single file already within the gulf and near the shore which was just what they wished at one signal they suddenly brought their ships round and sailed in a line as fast as each could against the Athenians hoping to cut off all their ships. Eleven of them however which were taking the lead escaped the wing of the Peloponnesians and their sudden turn xxxx, but the rest they surprised and drove them onshore in their attempt to escape and destroyed them killing such of the crews as had not swum out of them. Some of the ships they lashed to their own and began to tow off empty." The 11 ships which evaded the charge rallied shortly and took 6 ships but the advantage was with the Peloponnesians, Phormio had been forced to fight in narrow waters and was defeated.

The speech Thucydides gives is a treatise on fleet tactics: the men were onshore when the enemy was seen standing into the Gulf to attack a friendly city and were probably onshore always at night and during large part of the day. When they embarked for exercise or other purpose their tents were left standing until they should return. Crews were however addressed while in ships for Xenophon relates that in 405 B C the enemy being very near an admiral orders,[2] " His crews to go onboard their vessels. He then rowed alongside each ship in turn and addressed the

[1] Greek ships stopped the noise of rowing by muffling the looms of oars at the tholes and substituting soft sounds for the cry or song of the *keleustes* to give the cadence to oarsmen; Xenophon Dakyns trans Hell bk 5, 1, 7–10.

[2] Dakyns trans 4 vs v 1 p 39 Hellen bk 2.

men at some length in terms of encouragement and cheery admonition." So a modern commander might do. To further illustrate Phormio's ships it may be noted Thucydides recounts that it being intended to haul long-ships across the Isthmus of Corinth to operate near Attica,[3] "They proceeded to make ready at the Isthmus machines for hauling their ships with a view to transporting them from Corinth to the sea on the side of Attica and making an attack both by sea and land at the same time." A *diolkos* ship-railway and *ergatis* capstan would be used; the length of the haul is 5 miles.

Thucydides recounts [4] a mixed land and sea operation at Pylus near what is now called the Bay of Navarino and tells of men being in long-ships about 72 days, probably not without intermission but considerable part of the time. In consequence of this appearing to have been necessary the Assembly of the People of Athens, "Were afraid that winter might surprise them in the blockade. They saw that both carrying provisions round the Peloponnese would then be impossible xx and that the blockade by sea of so harbor-less a country could not be continued." [5] The Athenian blockade was off Pylus where the enemy held a shore position it was desired to capture and ships retired at times 7 or 8 miles to the Island of Prote to cook and eat their meals and to sleep; here they had tents or huts for the island was uninhabited.[6]

THE SECOND PART OF THE PELOPONNESIAN WAR; THE ATHENIAN FLEET SENT TO SYRACUSE.

Six years after the Ten Years' War closed that is in 415 Athens sent a fleet around the Peloponnese to Sicily,[7] which expedition has a place among those unwieldy military operations ending in overwhelming disaster. Nicias who was to command foresaw this and recommended what he deemed extravagant preparations: "Thus much spoke Nicias," Thucydides writes,[8] "Thinking that he should deter the Athenians by the vast scale of his measures xx. They however had not their desire for the voyage taken from them by the burdensome nature of the preparations but

[3] Bk 3, 15.

[4] Bk 4, 9–32; p 172 below.

[5] Thuc bk 4, 39 as to men in ships much of 72 days and 4, 27 as to maintenance of blockade.

[6] Thuc 4, 13.

[7] Thuc 6, 1–41; here is given debates of the assemblies in Athens and Syracuse revealing much of sea-ways: see below p 198 as to feeding the men in the ships.

[8] Bk 6, 24.

were much more eager for it than ever xx. So that owing to the excessive desire of the majority for the measure even if any-one were not pleased with it he was afraid that by voting against it he might appear ill-affected to the state and therefore held his peace." "For 4 winter months," Nicias told the Assembly,[9] "scarcely even a messenger can reach you." The voyage may be made in several ways: from Athens to Cape Malea the south extremity of Greece is 80 miles, and the coasts would be hostile forbidding landing to buy or prepare food or sleep. From Malea directly across the open sea to Syracuse is 330 miles, a distance the armada could not hope to cover in less than 4 or 5 days even with favorable wind. This route was not taken by the ships and there is no mention that it was even considered; it was a run such as long-ships at no time took not even in their last days when larger than in Greek days. The reason was they carried neither food nor water except what the men themselves brought onboard and undertook no voyage unless sure when they would reach food and water. Nicias' ships went north from Malea by the west of Greece until opposite the south of Italy, crossed here a distance of 80 miles, and proceeded coastwise to Syracuse. The distance by this route from Malea to Syracuse is 700 miles and thus the whole distance from Athens to the last is 800 miles. The ships were treated as enemies, refused food and at times water in the coast towns.

Because the fleet came by the longest route and after the manner of large fleets dawdled much the Syracusans were prepared when it arrived. Small fleets of long-ships have made bolder runs. Thucydides tells of one in about 412; writing,[1] "About the period of the winter solstice" a fleet of 37 Lacedæmonian ships put out from the Peloponnese for the S W corner of Asia Minor, 225 miles due east. They went first to the Island of Melos, 60 miles east with no islands on the way; thence to avoid the enemy they went straight south to Crete 90 miles where again there are no islands. Thence passing along the coast of Crete they steered for the east extremity of Caunus at the S W corner of Asia Minor where they were bound; this distance is 150 miles and there are intermediate islands. They might have taken a route further north where the distances between islands is shorter than in the route they went, but there were enemy's vessels in the north. The story of the expedition to Syracuse and the fighting there

[9] Bk 6, 21.

[1] Bk 8, 39; the season is Dec.

is in Thucydides 6th and 7th books.[2] The Syracusans had strengthened the bows of ships for ram-blows; [3] Thucydides says, "Some 7 Athenian ships were disabled being struck bow to bow and having their fore-ship stove in by xx the Syracusan ships which were provided with stronger parts for this very purpose." Of fighting in the harbor he says, "As a great number of ships were enclosed in a small compass for indeed they were the largest force fighting in the narrowest space that had ever been known since both of them fell little short of 200,[4] the attacks made with the beaks were few as there was no means of backing water or cutting through the enemy's line. Chance collisions were frequent just as one ship might happen to run into another either in flying from or attacking another. So long as a vessel was coming up to the charge those on her decks plied their javelins arrows and stones in abundance against her, but when they came to close quarters the heavy-armed soldiers fighting hand-to-hand endeavored to board each other's ships." [5]

After defeat on sea and land Athenian fugitives reached home in a manner unknown, but the ships were every one lost: it is said the story was made known in Athens by a man who had escaped telling a barber who ran out and proclaimed it.[6] The Athenians notwithstanding the wrecking of their hope of extending their dominion and loss in men and treasure, "Judged it expedient not to give way but bear up to the utmost of their power and especially to procure lumber and money from every possible quarter to prepare a fleet." [7] A year later they had fleets at sea.

STANDING THROWING-MACHINES AND FIRE-SHIPS IN FLEET ASSAULTING SYRACUSE IN 415 B C: ALSO A ROUND-SHIP OF 1000 TONS AND THEIR WAY OF FIGHTING.

Thucydides says there were standing throwing-machines at Syracuse[8] and that fire-ships were employed in attempts to burn the Athenian fleet,

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2 Also Plutarch's Nicias.

3 Above p 112.

4 The harbor was an ellipse 4200 and 3000 yards diameter: each vessel with oars in action would occupy about 40 x 15 yards; when all vessels were in the harbor each had a space about 50 times the area of her deck.

5 The statement abt strengthening bows is Thuc bk 7, 34 and 36; the one about fighting in the harbor 7, 70.

6 Nicias Plutarch Langhorne trans v 3 p 288.

7 Thuc bk 8, 1.

8 Bk 7, 25; the passage is above p 98.

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writing of the last,[9] "Wishing also to burn the rest of the ships the Syracusans filled an old round-ship with faggots and pine-wood and having thrown fire into her and the wind blowing right on the Athenians they let the vessel drift towards them. The Athenians alarmed for their ships contrived on the other hand means for checking and extinguishing it and having stopped the flames and near approach of the fire-ship they thus escaped the danger." Our historian says also that there was a round-ship of 10000 talents burden present, which assuming he means she could carry this weight indicates a ship of 1000 tons displacement,[1] and describes how round-ships fought by carrying heavy weights, *dolphins* they were called, at the yard-arms or ends of derricks and dropping them as enemy's vessels passed near.[2]

THE THIRD PART OF THE PELOPONNESIAN WAR.

After the Athenians were defeated in Sicily the theatre of war changed. Fleets are no longer found south and west of Greece but east and north in the region of the Hellespont. Athens has abandoned hostile operations elsewhere and is fighting to keep open the route by which her food-ships come from the Euxine and to hold revolted allies to the Delian Compact. She has lost the offensive but still equipped great fleets and fought pitched battles; at Ægospotamos 405 where her doom was sealed she had 180 ships.

Of the battles of these days only 2 will be noticed; Arginusæ in 406 and Ægospotamos in 405. Xenophon writes of the first that the fleet of Sparta[3] consisting of 120 ships under command of Callicratidas, "Hove to for the evening meal off Cape Malea in Lesbos opposite Mitylene. It happened that the Athenians on this day were supping on the Islands of Arginusæ which lie opposite Lesbos.[4] In the night the Spartan not only saw their watch-fires but received positive information that these were the Athenians, and about midnight he got under oars intending to fall on them

[9] Bk 7, 53. This is the earliest mention of these but they may have been used before; it will be noted they were brought out only when the enemy is reduced and failed.

[1] Bk 7, 25. The talent was 80 pounds: if the ship's empty hull weighed double the cargo she could carry her loaded displacement exceeded 1000 modern tons. See Grundy Thucydides p 306; Bunbury Anc Geog pp 324–5; Serre Mar de Guerre v 1 p 53.

[2] Above p 97.

[3] Hellen bk 1, 6. Thucydides' hist ends before this.

[4] The fleets were 8 miles apart: see map 27 Smith's Atl Anc Geog. The Athenians ate supper onshore after cooking it there and intended probably to sleep onshore: the Spartans were supping onboard.

suddenly. But a violent down-pour of rain with thunder and lightning prevented him putting out to sea. By daybreak it had cleared and he sailed toward Arginusæ. On their side the Athenian fleet stood out to meet him," Xenophon states next the Athenians were in 2 or 3 lines abreast one in the rear of the other and the Spartans in a single line abreast. The passage is involved and it is clear only that lines were formed abreast with beaks toward the enemy; the Spartan one line deep and Athenian more than one; and our author gives this explanation of the unusual formation, "The object of the Athenian formation was to prevent the enemy from manœuvring so as to break their line by sailing-through since they were inferior in sailing-power. The Spartans on the contrary xx were formed opposite with all their ships in a single line with the special object of manœuvring so as either to break the enemy's line or to wheel round them. xx And now the fleets approached and for a long time the battle endured. At first the vessels were engaged in crowded masses and later on in scattered groups. At length Callicratidas as his vessel dashed her beak into her antagonist was hurled off into the sea and disappeared xx. The losses on the side of the Athenians were 25 ships crews and all with the exception of a few who swam to dry land. On the Peloponnesian side 9 out of the 10 Spartan ships and more than 60 belonging to the rest of the allied fleet were lost." The Athenian fleet retired north to Arginusæ and the Spartan to the south. If what Xenophon says is accurate Athenian ships had lost efficiency since the days when the enemy was afraid of their charge,[5] which may well have been the case for 9 years before great part of their ships and sailors were lost at Syracuse.

Arginusæ has gained sinister celebrity because 6 of the 8 generals in command of the fleet of Athens all that returned to the city were put to death in accordance with a decree of the Assembly though it was admitted they had been victorious because they sailed away from the scene of battle without picking up their dead and rescuing their living clinging to capsized and water-logged hulls: their defense was the weather was threatening and the fleet must seek shelter. Subsequently the People repented and brought the accusers of the generals to trial for their lives for deceiving them. This savage and wanton act had result:[6] at the Battle of Naxos 376 B C Chabrias the Athenian commander, "Though he obtained the victory and

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[5] Above p 127.

[6] Demosthenes in 350 B C told the Athenians, "Every general of a fleet is twice or thrice tried before you for his life;" Orat Bohn pp 70–72 1st Philippic.

put the whole enemy's fleet to flight yet he would not pursue remembering the Battle of Arginusæ where though the Athenians were victorious, yet the People instead of a reward put the commanders to death only because they did not bury those who were killed in the fight. Fearing therefore the like fate he waived pursuit and took up the citizens swimming and floating here and there and so preserved those that were alive and ordered the dead to be buried." [7]

The other battle to be noticed is Ægospotamos. It occurred in the Hellespont the year after Arginusæ about 100 miles further north and many of the ships must have been in both battles. A homily might be said regarding the Athenians not pushing their advantage in the earlier action for their fleet was destroyed at Ægospotamos. Lysander, proved by his victory at Notium in 407, took command of the Spartan fleet after defeat at Arginusæ and owing to Spartan laws as to periods admirals might hold command had with him other officers nominally his superior: [8] Conon and other generals were sent out to command the Athenian ships after the execution of the former commanders. Upon taking office Lysander entered the Hellespont captured Lampsacus on the east side of the strait and anchoring there procured in the city the food and water his men needed, and probably billeted them in the houses. The Athenian fleet numbering 180 long-ships followed the Spartans into the Hellespont, anchored at Ægospotamos opposite Lampsacus and formed camp there for there was no town at the point. Both sides of the Hellespont were friendly to Athens.

The fleets were less than 2 miles apart moored with bow drawn to an anchor to seaward and stern touching bottom close to shore; the men in houses or tents being abreast of the vessels. The Spartans bought food [9] in Lampsacus or robbed the market but the Athenians because there was no town where their ships were were obliged to walk to Sestos 2 miles away for all they needed. It is probable many of the Athenian crews slept in Sestos. Now follows a tale of incredible folly: Xenophon says,[1] "At Ægospotamos a point facing Lampsacus where the Hellespont is not quite 2 miles broad the Athenians took their evening meal. The night following or rather early the next morning with the first streak of dawn Lysander gave the signal for the men to take their breakfast and get onboard their

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[7] Diodorus Booth trans v 2 p 25.

[8] Xeno Hell bk 2 ch 1.

[9] Above p 134.

[1] Hell bk 2, 1: Lysander Plutarch Langhorne trans v 3 p 99.

vessels, and so having got all ready for a naval engagement with his ports closed and movable bulwarks attached [2] he issued the order that no-one was to stir from his post or put out to sea. As the sun rose the Athenians drew up their vessels in line-of-battle ready for action but Lysander declined to come out to meet them and as the day advanced they retired again to Ægospotamos."

This was repeated by the Athenians on 4 successive days and each day Lysander remained inactive only sending scout-ships to follow the Athenians and report their movements. They were seen to land each day and disperse. As mentioned their ships were moored in a line with bow drawn to seaward to an anchor and stern lightly grounded in 3 or 4 feet of water: a fleet of 180 would occupy about one mile. The times were leisurely and discipline lax and probably few men were left to keep ship. When the Athenian fleet challenged on the 5th day Lysander remained inactive as before and as before sent ships to follow them, but the instructions this time were to return when the Athenians had dispersed on the shore and continues Xenophon, " When in mid-channel to hoist a shield." Xenophon goes on, " Lysander at once signalled to his whole fleet to put across with all speed. Aware of the enemy's fleet which he could see bearing down on him Conon had only time to signal to the crews to join the ships and rally to the rescue with all their might. But the men were scattered far and wide xx. Conon's own ship with 7 others xx put out to sea but xx every one of the remaining 171 vessels were captured by Lysander on the beach." Plutarch writes of the dash across the Hellespont,[3] " Conon was the first that descried them from the land. xx His men xx were dispersed up and down, some in the market-place some in the fields some were asleep in their tents and some preparing their dinner."

Xenophon says [4] Lysander, " Despatched Theopompus a Milesian privateer's-man to Lacedæmon to report what had taken place. This envoy arrived within 3 days and delivered his message." The distance is 225 miles, so they made 75 miles per day much being no doubt under sail. A peace closing the Peloponnesian War was made 404 B C and by its terms Athens was required to keep only 12 ships of war. Her navy grew soon

[2] The Spartans breakfasted *and* went onboard; they had probably slept onshore. I cannot explain what is meant by closing ports: ships used a covering for oar-ports (see above p 81; below p 400 for Northmen's use of this) but this was to keep dashing water out in a sea-way. The movable bulwarks were to place above the rail for shelter for oarsmen: see picture p 81 above.

[3] Lysander Langhorne trans v 3 p 99.

[4] Hellen bk 2, 1.

however to respectable size for in 340 B C the day of Philip of Macedon the Council and People resolved to send out a fleet of 200 long-ships.[5]

THE PUNIC WARS AND CONQUESTS OF ROME IN AFRICA AND ASIA.

The Punic Wars began 264 B C and from that date until 31 B C the Temple of Janus in Rome open during war remained open except for an interval at the end of the first Punic War. In 31 B C Octavius defeated Anthony at Actium deciding who should be master in Rome and war-fleets which had played large parts and fought many battles were suffered to disappear. The history of the time is told by Polybius a Greek who dwelt long in Rome and Livy a Roman citizen, the first being born about 200 B C and the last 60 B C: both write of sea-operations often telling much of technical character.

THE FIRST PUNIC WAR OR WAR FOR SICILY: 264 TO 241 B C.

Polybius calls this the War for Sicily. The term shows its nature since wars for islands are on the sea. It was entirely of that character, being caused by the determination of Rome to crush Carthage her great commercial rival and was precipitated by a body of soldiers in Messina on the Strait of Messina. The Romans realized they must wrest from Carthage her influence and control in Sicily lying athwart trade-routes in the Mediterranean, and when they crossed the narrow water between Italy and Sicily they entered on that long and little fore-casted war which issued in the formation of the Roman Empire. This momentous and far-spread contest of 200 years' duration was dependent throughout in major degree on ships and operations on the sea and those interested in its course and ending must keep the Mediterranean and ships ever in mind. The sea served like a net-work of railways in the theatre of the war extending everywhere and everywhere impossible to interrupt except by fleets of war-ships able to remain at sea.

Rome gained foot-hold in Sicily in 260 by winning the sea-battle of Mylæ.[6] Duilius commanded the Roman fleet and it is said the victory was

[5] Demosthenes Bohn v 5 p 72 Or on the Crown. See p 38 same v for a fleet of 120 sent out about the same time.

[6] The town of Mylæ was on a promontory jutting from the north shore of Sicily 25 miles west from the north end of the Strait of Messina. In 36 B C Agrippa who afterwards commanded in second to Octavius at Actium fought a battle 15 miles east from Mylæ with Sextus Pompey usually called the Battle of Naulochus, which battle is important because of the many throwing-machines used by the ships: see below p 190.

due to Roman ships being fitted with the *corvus* a bridge for boarding.[7] After Mylæ Rome sent an army to Africa, and the fleet carrying it met a Carthaginian fleet off Ecnomus on the south shore of Sicily in the year 257 and defeated it. We review further on circumstances of interest at Mylæ Ecnomus and later conflicts and expeditions, noticing now only principal movements. This Roman army landed in Africa and occupied positions there but accomplished nothing and 2 years later ships were sent to bring it home. On the way owing we are told to the commanders going counter to advice of the pilots the fleet was caught near the south of Sicily by an onshore gale and many ships were driven on the rocks or foundered: Polybius writes,[8] "Out of their 364 vessels only 80 remained xx. No greater catastrophe is to be found in all history as befalling a fleet at one time." The ship-of-the-line was larger than during the Peloponnesian Wars; from trieres triremes 3-oars they had become penteres quinqueremes 5-oars; Polybius says [9] these were manned by 300 rowers and 120 soldiers and thus 120000 men perished. The First Punic War was on the sea, there being no operations of consequence on the land; its fortune inclined now to the side of Rome and now to that of Carthage and its general course is shown by the fact that whereas at first battles were in waters near Rome and Italy they drew gradually away south and west towards Carthage, the last being off the west coast of Sicily about 80 miles from Carthage. In 249 the Roman fleet was defeated off Trapani in the west coast of Sicily and the war was brought to an end in 241 by a Roman victory near the Ægates Islands lying west of Sicily. The articles of peace required Carthage to evacuate Sicily Sardinia and Corsica; a portentous circumstance.

THE SECOND PUNIC WAR OR WAR OF HANNIBAL 218–201 B C.

The loss of the islands marks the downfall of Carthage the great daughter of Phenicia. Hannibal withstood the Roman armies for a time but cut off from home he could but fail. After the defeat of the Carthaginian fleet at the Ægates Islands opposite the modern city of Trapani in Sicily, bringing the First Punic War to an end and forcing Carthage to give up the islands, Rome's control of the Mediterranean was never threatened. In 229 12 years after Ægates Rome began to extend

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7 Below p 178.

8 Bk 1, 37: p 178 below as to Ecnomus.

9 Bk 1, 26: below p 160 n 7; p 179 n 8 as to size of 5-oar vessels.

east seizing in that year positions on the east shore of the Adriatic, and though her serious attention was presently turned west these were never abandoned. From 218 she was occupied in Spain and Italy by Hannibal, but her fleet was everywhere dominant, able to support and strengthen her armies and prevent Hannibal and Carthaginian generals in Spain and Italy from receiving help from Carthage or their allies east of the Adriatic.

Rome held Sardinia Corsica and all Sicily except Syracuse, which city was independent, when the Second Punic War began, together with positions east of the Adriatic and in Spain. Hannibal was already in Spain with an army and after capturing the city of Saguntum crossed into Roman territory and led her army over the mountains into Italy. These events occurred in 218 B C and led to open war between Carthage and Rome. Before Hannibal crossed the Iberus[1] the Roman Assembly,[2] "Decreed for the service of the year 6 legions with such a number of the troops of the allies as the consuls should deem requisite and a fleet as great as could be fitted out. Of Romans were enlisted 24000 foot and 1800 horse, of the allies 40000 foot and 4400 horse. The fleet put to sea consisted of 220 ships of 5 banks of oars and 20 light vessels." Livy says 160 quinqueremes and 12 light vessels were assigned to service near Sicily and Carthage and 60 stationed in Spanish waters, adding, "It was not supposed either that the enemy would come by sea or that he would exert his effort on that element." The total Roman land force at the outset numbered then 70200 while the complement of the 220 quinqueremes commissioned, taking them at 420 the figure given by Polybius,[3] is 92400.

These being the land and sea forces of Rome at the beginning the history of the war must include examination of operations at sea, an impression which is strengthened by consideration of the theatre of war and by statements in the Roman writers as to ships. At the beginning of hostilities the Roman fleets were actively employed: Ammianus Marcellinus writes of opposition to Hannibal,[4] "Publius Cornelius Scipio the father of

[1] The campaign has never been examined in regard to sea operations. The accounts are entirely Roman: Livy describes the passage of the Rhone by Hannibal's army bk 21, 26–28; elephants were carried across on rafts, one of them 200 by 50 ft; "The horses were led after the ships' sterns by collars, those only excepted which had been put onboard the ships bridled and accoutred in order that the riders on landing might have them instantly ready for use."

[2] Livy Baker trans bk 21, 17.

[3] Above p 151. In no war of modern day has the force enlisted in the navy reached that in the army.

[4] Hist Bohn bk 15, 10–11 p 77. Marcell wrote 400 A D. Livy who died 18 A D describes this crossing bk 21, 33–38 and this campaign of Hannibal bk 21, 6–38.

the elder Africanus xx led to the Spanish coast a fleet having onboard a numerous army. But after Saguntum had been destroyed by the valor of the Carthaginians being unable to overtake Hannibal who had crossed the Rhone and had obtained 3 days' start of him in the march toward Italy he crossed the sea which at that point was not wide making a rapid voyage and taking his station near Genoa a town of Ligures awaited his descent from the mountains; so that if chance should offer him an opportunity he might attack him in the plain while still fatigued with the ruggedness of the way by which he had come. But still having regard to the interests of the Republic he ordered Cnæus Scipio his brother to go into Spain to prevent Hasdrubal from making a similar expedition from that country. But Hannibal having received information of their design from some deserters, being also a man of great shrewdness and readiness of resources, obtained some guides from the Taurini who inhabited those districts, and passing through the Tricastini and through the district of the Vocontii, he thus reached the defiles of the Tricorii. Then starting from this point he made another march over a line previously impassable. And having cut through a rock of immense height which he melted by mighty fires and pouring over it a quantity of vinegar he proceeded along the Druentia a river full of danger from its eddies and currents until he reached the district of Etruria." [5]

Thus by transporting an army across sea a thing they would not have ventured on if a Carthaginian fleet had been close the Romans nearly intercepted Hannibal's march. In the following year 217 there was a battle on the coast of Spain off the Iberus between 35 Roman and 40 Carthaginian ships the former winning a decisive victory; of this Livy writes,[6] "The most brilliant circumstance was that by this one battle which cost them so little the Romans rendered themselves masters of the sea along the whole extent of that coast." Livy writes as to manning Roman fleets,[7] "There being a scarcity of seamen the consuls in pursuance of a decree of the Senate published a proclamation that every person who in the censorship of xx had been rated or whose father had been rated at $812 or from that sum up to $1615 or had since acquired such property, should

[5] The rock melted by mighty fires must be the foundation for the tale that Hannibal blasted a way across the Alps with explosives; Hennebert Vie Annibal v 2 p 253. It was 800 years after Hannibal explosives were first known in Europe: the Feu Gregeois, below pp 435 and foll'g. Vinegar was believed in ancient time to have power in extinguishing flame but here only is it said to melt rocks.

[6] Bk 22, 19–20, Baker trans. The passage entire is below p 180.

[7] Bk 24, 11. The amounts of money stated are from Baker trans 6 vs v 3 pp 204–5 ed 1797 foot-notes.

furnish one seaman with pay for 6 months; every one rated from $1615 to $9335 3 seamen with pay for a year; every one rated from $9335 up to $16145 5 seamen; every one rated higher 7; and that senators should furnish 8 seamen each with pay for a year. The seamen furnished in obedience to this ordinance being armed and equipped by their owners went onboard the ships with provisions ready dressed for 30 days. This was the first instance of a Roman fleet being manned at the expense of private persons."

The city of Syracuse when Sicily came into the Roman dominion remained an independent kingdom. By sea it is 260 miles from Carthage and 60 from Italy and thus might serve as a base for operations. Hannibal's victory at Cannæ was after he had been 2 years in Italy cut off from succor except by detour through Spain and menaced everywhere by Roman armies; after it his way to Rome would seem to have been open. We are without evidence to show he hoped for aid by way of Syracuse but in 215 the year following Cannæ Rome invested that city by an army and fleet under Claudius Marcellus which captured it after a 3-years' siege.[8]

Livy says that before Syracuse was invested the Carthaginian admiral Himilco, " For a long time kept his fleet at the promontory of Pachynum xx." [9] Later this admiral landed 28000 men and 12 elephants at the same point and at the time of the landing 214 B C our author says,[1] " 55 Carthaginian ships-of-war commanded by Bomilcar put into the harbor of Syracuse and a Roman fleet of 30 quinqueremes landed a legion at Palermo. It seems as if the theatre of war was moved hither from Italy so intent were both nations on the affairs of Sicily xx. The Carthaginian ships did not delay long at Syracuse. xx Bomilcar was diffident of success as the Romans had a fleet of at least double his numbers xx." There can be little doubt the War of Hannibal was lost when Carthaginian operations in Sicily failed and Syracuse fell, but whether failure was due to Himilco Bomilcar or other admiral or to the War Office in Carthage it is impossible to say.

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[8] Livy 23, 31; Polybius 8, 3. During the siege many throwing-machines designed by Archimedes were used; Livy 24, 34, and when the city fell he was wantonly slain by a Roman soldier, being at the moment engaged it is said in study of a geometrical problem.

[9] Bk 24, 35: now called Cape Passaro, the south-east corner of Sicily.

[1] Bk 24, 36.

The Romans captured Syracuse in 212 [2] closing the southern and best way for re-enforcement to reach Hannibal; his hope of aid from allies east of the Adriatic was never good for Rome had held important posts there since 229, and his cause became desperate when the Carthaginian army was defeated at the Metaurus in 207 closing avenues by the north. Rome then sent an army into Africa under Scipio and the end came when Hannibal thus drawn out of Italy met Scipio at Zama in 202 and was defeated.[3]

OTHER OPERATIONS OF CARTHAGINIAN FLEETS DURING HANNIBAL'S WAR.

Operations by sea not yet noted were attempted by Carthage. In 206 the year after the Metaurus the commander of a fleet at Cadiz was ordered to effect a junction with Hannibal in Italy, " Money to answer this purpose being sent him ": he went as far as the Balearic Islands and lay there over winter.[4] In 205 the next year Livy writes,[5] " There were 80 round-ships of the Carthaginians taken on the coast of Sardinia xx laden with corn and provisions for Hannibal." The army must have been in great difficulty or such a chance would not have been taken: from Carthage by the mid-sea between Sicily and Sardinia steering for the coast of Italy and passing out of sight of the islands—for both were Roman—is 300 miles; such a run was easily within the power of round-ships but not of long-ships while the former were helpless in battle. If we take Livy's words literally the round-ships were not accompanied by war-ships; they chanced meeting the enemy. It also results that the round-ships were lying at sea waiting a suitable opportunity to reach the port they were to make; in such circumstances long-ships would soon be without water or food.

In logistics, the science of moving supporting and supplying military expeditions, the ancients were proficient and surely the departments in Rome and Carthage used war-maps. From Spain Hannibal marched

2 It seems Carthaginian fleets carrying men and supplies could have run through the blockading fleet an operation not uncommon in ancient times, Diodorus bk 20, 1, 5.

3 The circumstances of Scipio's crossing are given below p 182.

4 Livy 28, 36–7: that money and not stores was sent should be noted and that the fleet was in the Ocean; but Livy does not deem it worth while to comment on this. Fleets were there not uncommonly: Polybius commanded a fleet there; Pliny Nat Hist bk 5; pp 281–3 v 1 Du Sein Hist de Marine is a chart showing route of the fleet: the circumstance is not in Polybius' Hist. The passage of Livy just given will be found complete below p 184: it is of much interest.

5 Bk 28, 46.

into Italy and through its length procuring supplies and recruits from the territory passed through, hoping always for aid from the east across the Adriatic, where Roman fleets blocked the way; from the south from Carthage by way of Syracuse, where again Roman fleets were; and from the north. The theatre was large, the ways by which the army could be succored were 2 by sea and one by land and to examine possibilities by the former and use war-maps only the day's-run of ships had to be determined, and Polybius born not long after the Second Punic War says a day's-run for a round-ship is 100 miles.[6] It is the same today.

The date by which round-ships reached capable condition is earlier than that of Polybius: Thucydides wrote 250 years before him,[7] "The voyage around Sicily in a round-ship is one of not less than 8 days." The distance from one head-land to the next around Sicily is 500 miles and a sailing-ship of the present time would do fairly well to circumnavigate the island in 8 days. In another place Thucydides states a round-ship can run from Abdera to the mouth of the Danube 550 miles in 4 days, "Supposing the wind to be always steady astern." [8] This is 140 miles per day and the wind must be fair always. Herodotus measures by day's-runs of 130 miles.[9] Thus Herodotus in 470 B C, Thucydides 50 years later, Polybius 300 years after Herodotus, put a day's-run at 100 to 150 miles. Maury 2000 years after Polybius deems 100 days from New York to San Francisco a wonderful performance for clipper-ships, which as the distance is 15000 miles is 150 miles a day.[1] Round-ships have changed little.

The maps in the War Departments in Rome and Carthage during the Punic Wars were like those of modern day; War and not Navy Departments because although operations on the sea were of the greatest importance yet until hundreds of years later there was no separation between military forces on land and sea. There were seamen who never served in the army and soldiers who never became seamen, but the separation now universal was adopted only when war-ships came to be moved by sails, 1550 to 1850. Even after 1550 except in a few countries fleets and ships were to some

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[6] Bk 4, 41.

[7] Bk 6, 1. Statements like this show how maps were made: we put areas on the map by determining the latitude and longitude of a number of positions by astronomical observations and triangulating across from one of these to the next. The ancients could triangulate but had not the astronomical instruments we have and determined large areas and those including water across which one cannot see by runs of ships.

[8] Bk 2, 97; below p 222.

[9] Bk 4, 86.

[1] Physical Geog Sea ed 1857 pp 338–43.

extent managed by landsmen. The ground may be taken that the conduct of war should be under one control.

THE THIRD PUNIC WAR.

Rome made war on Carthage for the 3d time in 149. The peace made in 201 after the Second War required Carthage,[2] "To hand over all ships-of-war except 10 triremes"; the jealousy of Rome was soon aroused however by Carthage's ships and trade, and Cato a Roman statesman carried fresh figs into the Senate we are told and holding them up declared,[3] "The country where these grew is but 3 days' sail from Rome xx. Carthage must be destroyed." The distance by sea from Carthage to Ostia, the port of Rome at the mouth of the Tiber, is 300 miles; again we have 100 miles as the day's-work of a round-ship.

Carthage was already weakened and a Roman victory off the city in 146 brought the war to an end: the Roman commander,[4] "Caused all the bucklers engines and ships to be piled together and being girt after the manner of the Romans set fire to them." Livy says the war-munitions destroyed comprised,[5] "Catapultas of the larger size 120; of the smaller 281; balistas large 23 small 52; of scorpions large and small of arms and missile weapons a vast number." The catapultas were probably partly swinging-beam machines and partly cross-bows to use in horizontal fire in the field or ships; the scorpions and the rest portable missile weapons and arms and armor.[6] Thus Carthage for nearly 1000 years the great mart in the western Mediterranean was destroyed in 146 B C, and in the same year Rome destroyed Corinth among the great sea-ports in the eastern end of that sea: while both were re-built and re-peopled in later date neither reached a great importance.

THE ADVANCE OF ROME IN THE GRECIAN PENINSULA AND ASIA.

The plan of noticing events only so far as concerns the part seamen played will be adhered to as before and much of this character is found in the authorities for the period; the larger operations of the wars the

[2] Polybius bk 15, 18.

[3] Cato Plut Langhorne trans v 2 p 335.

[4] Appian of Alex trans J D 2nd ed 1692 p 59. There is a recent trans of Appian by Horace White published by the Loeb Classical Library in 4 vs; the English and Greek text is given whereby the Greek names of ships' parts may be distinguished.

[5] Bk 26, 47: Livy lived 100 years after.

[6] Below p 186 for other details.

strategy is uninteresting because the Romans advanced with the sureness of fate. There is no figure like Hannibal deep in the enemy's country and surrounded by uncertainty and danger to arouse interest and sympathy. It has been mentioned that Rome despatched a fleet to the east side of the Adriatic in 229 B C and that positions then seized were never abandoned; [7] from these she advanced over the Greek peninsula into Asia Minor Syria and Egypt. After Zama the fleet returning from Africa was not demobilized as we would say but sent to the east side of the Adriatic. Livy writes the Roman Senate decreed,[8] "That Publius Ælius consul should send such persons as he should think proper vested with command to receive the fleet which Cneius Octavius was bringing home from Sicily and pass over to Macedonia." Unfortunately for Macedonia, lying east of the Roman positions, its fleet was on the far side of the Ægean where it fought a battle at this time with an allied fleet of Pergamos and Rhodes,[9] and the Roman fleet crossed unopposed: very soon there occurred a battle between Roman and Macedonian armies at Cynoscephalæ at which the latter was totally defeated.[1]

All the East saw and feared the coming of Roman domination and in 192 Antiochus King of Syria crossed the Ægean with a fleet of,[2] "Forty decked ships and 60 undecked ones followed by 200 round-ships laden with provisions and war-stores xx 10000 foot-soldiers 500 horse and 6 elephants." This force seized the Chersonesus the neck of land west of the Hellespont and posted garrisons there, particularly at Lysimachia where the peninsula meets the main-land. Our historian adds in derision that Antiochus told the Greeks whose alliance against the Romans he looked for that an innumerable army was coming across the Hellespont to join him and,[3] "Naval forces which no harbor in Greece was capable of containing xx. Boasting of clouds of horsemen and footmen and covering the seas over with his fleets." In the year following his army was cut to

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[7] P 151.

[8] Bk 31, 3: the year is 201 B C.

[9] Near Chios off the coast of Asia Minor; Polybius 16, 2–10: for comment see Serre Mar de Guerre v 1 pp 119–134. The larger movements of the fleets are bk 31 Livy.

[1] Dio's Rom Hist Foster ed v 1 p 280; Polybius 18, 36–39; Livy 33, 13 and 15. After the battle Flaminius the Roman general, "Took away all the Macedonian ships except 10;" Flaminius Plutarch Langhorne trans v 2 p 373. The year was 197 B C.

[2] Livy 35, 43: 2 round-ships to each fighter.

[3] Livy 35, 48–49.

pieces by the Romans at Thermopylæ, Antiochus flying from the rout to Asia Minor by ship and debarking at Ephesus.

Several Roman fleets were in the East during these events and no attempt was made perhaps none could be made to prevent their uniting. Before Thermopylæ was fought a fleet of decked-ships sailed from Rome and after collecting others from allies joined ships already at the Piræus; the united fleet consisted of, "81 beaked-ships besides many others of inferior rates, some of which were open and furnished with beaks others without beaks fit for advice-boats."[4] This Roman fleet crossed the Ægean to Corycus in Asia Minor, within the south end of the Island of Chios. It consisted now of, "105 decked-ships and 50 open ones."

THE BATTLE OF CISSUS.

The fleet of Asia was at Ephesus, whence to Corycus where the Roman fleet of 105 decked and 50 open ships lay is W N W 50 miles. King Antiochus joined his fleet at Ephesus with a squadron from the Hellespont and summoned a council of officers by whom it was resolved to fight at once because ships of Rhodes were on the way to join the Roman fleet. The fleet of Asia numbered 70 decked and 30 open ships: though inferior to the Romans it advanced to Cissus, when, the Romans being still at Corycus, the fleets were 7 miles apart.[5] Here the fleets fought; the line of the Romans must have been 3 and of Asia 2 miles long assuming the ships were in single line. The Romans captured, "13 ships together with the rowers and soldiers and sunk 10" and themselves lost 1 ship.[6] The fleet of Asia returned to Ephesus followed by the Romans after lying-over a night at Corycus where no doubt they had tents or were billeted in houses. As the Romans proceeded to Ephesus they were joined by a fleet of 25 decked-ships from Rhodes; proving the wisdom of the council at Ephesus.

The Roman fleet of 130 decked-ships formed line-of-battle off Ephesus but the ships of Asia did not come out to fight. Livy says, his prejudice is natural and invariable, "Having thus extorted from the

[4] Livy 36, 42. The united fleet included ships of Eumenes King of Pergamos. This Kingdom lay north of Ephesus on the west shore of Asia Minor. In 133 B C on death of a king without heir he bequeathed his Kingdom to the Roman People, who named it the Province of Asia.

[5] Cissus and Corycus are on the south side of the promontory jutting towards Chios from the main-land. The year was 191 B C.

[6] Livy 36, 43–45: Appian trans J D ed 1692 p 71. Livy must mean 10 ships stove and sunk to the rail for they would hardly sink altogether and 13 captured by surrender.

enemy a full confession of being defeated the Romans sent home the Rhodians and Eumenes and steered their course to Chios." From Chios the Romans went north to Cannæ within the dominion of King Eumenes of Pergamos where, " As the winter now approached the ships were hauled on the shore and surrounded with a trench and rampart." [7]

THE BATTLE OF MYONNESUS.

Cissus was in 191 and the next year 20 miles further west and with many of the same ships Myonnesus was fought.[8] This is the name of the promontory on the east side of the bay 15 miles wide a little east of Cissus and Corycus and 25 miles W N W from Ephesus. During the winter following Cissus efforts were made to increase the fleets of both Rome and Asia. King Antiochus sent Hannibal a fugitive at his court from Roman vengeance after Zama to Syria to bring up Phenician and other ships. After assembling these and while returning to the main body Hannibal's fleet numbering,[9] " Thirty-seven ships of larger rates among which were 3 of 7 and 4 of 6 banks of oars and besides these 10 of 3 " met off the River Eurymedon an enemy's fleet of 32 ships of 4 and 4 of 3 banks of oars, and a battle was fought in which Hannibal's fleet must have been worsted since it did not join Antiochus at Ephesus.[1] It would be useless to attempt to compare the strength of the fleets but the ratings should be noted for many are heavier than any we read of in the Punic Wars.

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[7] Livy 36, 45 for the 2 quotations; the 2d is below p 163. The size of the ships is important: Polybius says bk 1, 26 the quinqueremes at Ecnomus 100 years earlier had 300 rowers and 120 soldiers, and it may be concluded their empty hulls weighed 200 to 250 tons. Admiral Serre believes (see several places v 1 Mar de Guerre, particularly cut p 75) they were not as large as Polybius makes them; but Polybius was almost contemporary was long a resident in Rome and is much esteemed because of accuracy. In Polybius bk 1, 63–64 will be found words in justification of his figures for numbers and sizes of ships very much as though he foresaw he might be disbelieved. As regards beaching or hauling onshore battle-ships see p 179 below. There is no quality of ancient and mediæval war-ships more interesting and admirable than their ease of communicating with the land.

[8] Below pp 162 and foll'g for details.

[9] Livy 37, 8 and 22–25.

[1] The Eurymedon flows into what is now called the Gulf of Adalia in the south shore of Asia Minor: here in 470 B C a Greek fleet defeated the Persians; Hannibal's battle alluded to was in 190; on the east side of the gulf 50 miles from the mouth of the river Pompey defeated the fleet of the pirates in 67 B C (see p 168 below); on its west side 30 miles from the river is Phaselis where a Saracen fleet destroyed the fleet of the Emperor Constantinus of Constantinople in 655 A D: p 376 below.

LIVY TELLS HOW SHIPS CUT THE LINE AND RAM THE ENEMY ASTERN.

In Livy's account of this battle of Hannibal there is a passage the like of which is found nowhere else; he says ships passed through open water between the ends of oars of enemy's ships and attacked on the stern: his words are [2] "The goodness of the Rhodian ships and the expertness of their men quickly relieved them from all embarrassment; xx when any made a stroke with its beak against an enemy it either shattered its prow or swept off its oars or passing by it in the clear space between the vessels made an attack on the stern." The ships were of large rates and must have been as much as 100 feet from out to out over ends of oars; the distance between centers of ships in line must have reached 400 feet and thus the larger fleet was 4 miles long. Neither here nor elsewhere is there mention of precautions taken to guard oars though when passing between ships one's own oars would be in grave danger. They must have been cared for in some way, laid out of harm's way quickly and resumed quickly when the enemy had passed.[3] Another thing arising from Livy's words may be noted; after passing through the line the Rhodian ships made an attack on the stern: it is not said the ships turned 180° but is implied for otherwise the ram-blow would be oblique on the quarter; of little effect and easily evaded. The explicit statement that ships traversed the line and attacked the stern is an indication that they could back to advantage and trail oars both of which exclude complicated ways of placing oarsmen.

SHIPS CARRYING POTS OF BLAZING FIRE ON SPARS PROJECTING FROM THEIR BOW.

In the same year as Hannibal's sea battle, 190 B C, a fleet of 36 under command of Pausistratos was caught in harbor by overwhelming force and attacked by land and sea: Livy writes,[4] "Pausistratos ordered all to go onboard their ships. This produced the greatest dismay and confusion among both sailors and soldiers who seeing themselves enclosed by the enemy on land and sea at once hurried onboard like men running away. The only method of saving the fleet that occurred to Pausistratos was to force through the narrow entrance of the harbor and push out into the open sea and as soon as he saw his men embarked ordering the rest to

[2] Bk 37, 24: the date is the winter of 191–190.
[3] Above p 30 for representation on ancient ships of what may be trail-lines for oars.
[4] Bk 37, 9–11.

follow he himself led the way and with the utmost exertions of his oars pressed to the entrance of the harbor. Just as his ship was clearing the harbor the commander-in-chief of the enemy with 3 quinqueremes surrounded it.[5] The vessel shattered by their beaks sunk; the crew was overwhelmed with weapons and among them Pausistratos gallantly fighting was slain. Of the rest of the ships some were taken outside the harbor some within and others xx while putting off from the shore. Only 5 Rhodian and 2 Coan ships effected an escape making a passage for themselves through the thick of the enemy by the terror of blazing flames; for they carried before them on 2 poles projecting from their prow a great quantity of fire contained in iron vessels."[6] This appliance is recorded again about 1350 A D as used by ships of that day;[7] in effect it is the same as the torpedoes carried on spars projecting from the bow 50 years ago.

EARLY NOTE OF THE RULE THAT UNDEFENDED OBSTRUCTIONS IN HARBORS ARE USELESS.

In a council of war held 190 B C it was asked, "Whether when by sinking the ships they should have barred the way to the sea their own fleet would be at liberty to go away and succor their allies and infuse terror into their enemies;" and answered, "If the fleet should withdraw who could doubt that the enemy would weigh up the hulks that were sunk and open the port with less labor than it had cost to shut it."[8] This goes to prove the effectiveness of missile arms standing and portable, for it would be with these the enemy would be driven from attempts to remove dormant obstructions.

THE BATTLE OF MYONNESUS.[9]

A squadron from a Roman fleet sent to the Hellespont to drive the forces of Antiochus from that region and bring the Roman army across into Asia was recalled to Cannæ in the spring of 190 and at this time the Romans, "Drew out the ships that were in dock at Cannæ."[1] In the autumn

[5] Livy gives neither rating or number of Pausistratos' ships; he had 36 a little earlier, bk 37, 9, but not all these were in the harbor: the enemy had 70 decked ships.

[6] See also Polybius 21, 7; Appian Eng ed 1672 p 72.

[7] Pots of flaming fire carried on spars projecting from ship's bows appear in pl 12 and 13 Reinaud and Favé's Feu Gregeois and p 275 of its text say they are from pictures on a mss of the 14th century in the Paris Library: see picture p 108 above.

[8] Livy 37, 15.

[9] Above p 160.

[1] Livy 37, 12.

preceding the arrangement made was to, "Leave 4 quinqueremes for the defense of the city of Phocæa, the rest of the fleet proceeding to Cannæ where as the winter now approached the ships were hauled onshore and surrounded with a trench and rampart."[2] The fleets did not at once seek each other and fight but held councils of war, at one of which the Roman commander-in-chief declared himself disposed to go north with the entire fleet and bring the army across the Hellespont, but was persuaded to keep most ships near the fleet of Asia while King Eumenes went north with a squadron to ferry the army across. Those who have followed the history of wars will see in this a case of the *fleet-in-being* theory. Some say a fleet must destroy the enemy's fleet before entering on other operations; a question much discussed in England about 1690 because of the inconclusive nature of an action between English and French fleets off Beachy Head in that year. The English admiral Torrington used the phrase fleet-in-being in defending his failure to attack vigorously to indicate that as long as the English fleet was in being the French were forced to inaction while if he engaged and were defeated the coast of England would be unprotected. Circumstances in which the question has arisen have occurred very often and the bolder course of proceeding without waiting to destroy the enemy's fleet has not uncommonly been taken: by Julius Cæsar more than once. In the council preceding Myonnesus the Roman commander was over-ruled in his intention of taking the bolder course.

We come now to the Battle of Myonnesus 190 B C which opened Asia to Roman arms.[3] The Roman fleet challenged by forming line-of-battle before Ephesus where the fleet of Asia lay but Antiochus did not come out. The Romans were obliged shortly to go to Chios for provisions and put into the harbor of Teos, within the bay of which Myonnesus is the eastern and Corycus the western promontory, and the fleet of Asia to prevent the Romans plundering their friends in Teos followed and anchored at Macris, a small island 8 miles to seaward of the Roman position. The Romans at first unaware the enemy's fleet was so near were informed of this by their scouts, the crews of the ships being dispersed in search of food: the

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[2] Livy 36, 45; 37, 12: part of this passage is p 160 above. Modern coppered wood ships lose their best speed in 4 or 5 years. An oarsman would be quick to recognize anything making the ship hard to row and it is probable ships were often hauled on land to dry though the reason given here by Livy is other: the Roman poet Horace wrote about 40 B C, "Severe weather is relaxed xx and engines haul from land the dry ships"; Smart prose trans, ode 4 p 6 ed 1850: see below p 225.

[3] Above p 160 as to place of battle.

embarkation is thus described by Livy,[4] "Trumpets sounding xx to call such as might have straggled into the country xx to hasten onboard. xx Scarcely could each know his own ship or make his way through the tumult. xx The Commander's ship sailed out first xx; he put each into his own place to form a line abreast xx while Eudamus waited at the shore xx that each ship as soon as it was ready might sail out." The ships were lying, the crews being onshore, in 4 or 5 feet of water and the men waded out and climbed onboard by ropes or ladders for the height of the rail of the larger ships from the water was about 9 feet.[5] There were 80 ships-of-the-line in the fleet of which the crews would number 35000 men and these went onboard their ships and formed line outside; the ships being huddled at Teos where facilities for so many must have been poor. It is stated by Livy that Antiochus' admiral considered whether to attack as the Romans came out but results from the narrative that the Roman embarkation and forming line was so speedy that opportunity was not given for this advantageous manœuvre.[6]

Livy goes on,[7] "The Romans were between Myonnesus and the promontory of Corycus when they first got sight of the enemy xx. The King's fleet which was coming in a long line with only 2 vessels abreast then formed themselves in order-of-battle stretching out their left division so far that it might go round and inclose the right of the Romans. When Eudamus who commanded in the rear perceived that the Romans could not form an equal front but were just on the point of being surrounded he pushed up his ships and they were Rhodian ships but far the fastest sailers of any in the whole fleet; and having filled up the deficiency in the extent of the line he opposed his own ship to the Commander's onboard which was Polyxenidas.[8] The whole fleets were by this time engaged in every part. On the side of the Romans fought 80 ships of which 22 were Rhodian. The enemy's fleet consisted of 86 ships, they had

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[4] Bk 37, 29: the passage is longer than given: see below p 181 for embarkation in 217 B C; also p 185.

[5] See drawing p 41 v 1 Serre Mar de Guerre: the height from the bottom of the quinquereme shown to her upper rail is 14 feet; the feet of a man wading would be at the level of the ship's bottom and his head 8 to 9 feet below her rail.

[6] Livy 37, 27. Myonnesus about to be described and Cissus the year before were fought 20 miles from where the battle of Notium occurred in 407 B C between Athenian and Spartan fleets toward the end of the Peloponnesian War.

[7] Bk 37, 29: the larger operations are 37, 31. The events were 200 years before Livy's day.

[8] Commander-in-chief of Antiochus' fleet and a Rhodian. There were Rhodian ships in the Roman fleet but none in that of Antiochus.

of the largest rates 3 of 6 and 2 of 7 banks. xx The Rhodian vessels that carried fire before them xx proved here the principal means of victory. For the King's ships through fear of the fire in their way turned aside to avoid encountering the enemy's prow with their own so that they could not strike their antagonists with their beaks but exposed the side of their own ships open to his strokes. If any did venture an encounter it was immediately over-spread with the fire that was poured in and the men were more hurried and disordered by their efforts to quench the flames than by fighting. However the bravery of the soldiers [9] as is generally the case was what chiefly availed in deciding the fate of the battle. For the Romans having broke through the center of the enemy's line [1] wheeled about and fell on the rear of the division which was engaged with the Rhodians and in an instant of time both Antiochus' center division and the ships surrounded on the left were sunk. The squadron on the right xx when they saw the other surrounded and Polyxenidas' ship deserting its friends and sailing away quickly hoisted sail and betook themselves to flight having a favorable wind for Ephesus. They lost in the battle 42 ships, of which 13 struck and fell into the hands of the Romans the rest were burned or sunk. Two Roman ships were so shattered they foundered and several were much damaged. One Rhodian vessel was taken by an extraordinary casualty; on striking a Sidonian ship with its beak its anchor thrown out of its own ship by the force of the shock caught fast hold of the other's prow with its fluke xx. The Rhodians xx pulled back, by which means the cable being dragged forcibly and being at the same time entangled with the oars swept off the whole set on one side. The vessel thus crippled became the prize of the very ship it had wounded with its beak and grappled. Such was the issue of the sea-fight at Myonnesus."

A FLEET OF ROW-SHIPS SAIL INTO BATTLE IN SINGLE LINE CLOSE-HAULED IN 191 B C.

Livy says ships of Asia *left* this battle under sail with favorable wind, and long-ships are often stated to have done this. There is a case in which they sailed *into* line-of-battle; no easy task, for Nelson said before Trafalgar and of the comparatively few ships he had that a forenoon

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[9] P 171 below.

[1] They broke through by hand-to-hand fighting from the ships; not by the ships breaking the line: how were the oars handled in wheeling about?

entire might be thus occupied: Livy writes of events in 191 B C,[2] "The fleet now consisted of 105 decked-ships and 50 open ones; on setting sail it was forcibly driven toward the land by the north wind blowing across its course and the ships were thereby obliged to go singly one after the other in a thin line." This fleet when approaching the enemy changed from line ahead to line abreast; the ships, "Furled their sails lowered their masts xx and waited for the ships coming up behind. xx Two ships fall upon one of the enemy; in the first place they swept away the oars from both sides; then the armed men boarded and killing some of the crew and driving others overboard took the ship. xx Livius xx in the commander's ship xx advanced to the attack; he ordered the rowers on both sides to plunge their oars in the water in order to hold the ship steady and to throw grappling irons into the enemy's ships as they came up. Having by these means rendered the business something like a fight on land xx." Only at the last were sails furled and oars manned.

THE ROMANS CROSS INTO ASIA.

The enemy having been destroyed at Myonnesus and the way open the Roman army crossed the Hellespont into Asia and a battle on land followed at Magnesia near Sardes in which Antiochus' army was routed. Peace was made 188 B C; it required Antiochus to,[3] "Surrender up all his elephants and not procure others. He shall also surrender his ships-of-war and their stores and shall not keep more than 10 light trading-vessels none of which is to be worked with more than 30 oars nor a galley of one tier of oars for the purpose of an offensive war; nor shall any ship of his come on this side of the promontories Calycadnus and Sarpedon except it shall be a ship carrying money tribute ambassadors or hostages." The reduction of Antiochus' power did not satisfy the Romans however for 20 years later a commission was sent, "With instructions first of all to burn the decked-ships next to ham-string the elephants and generally to weaken the forces of the kingdom." [4]

The advance of Roman arms over-sea may be summarized as follows: in 264 B C fleets were sent to attack Sicily and Africa; in 229 positions on the far side of the Adriatic were seized and the fleets and garrisons sta-

[2] Bk 36, 43–4: a fleet of 155 sail would be 3–5 miles long when in one line. The formation here described is the close-hauled line ahead of sailing battle-ships. See p 471 below.

[3] Livy 38, 38.

[4] Polybius 31, 12; Appian trans J D p 83.

tioned there were increased in 201; following victories in the Greek peninsula fleet actions were fought at Cissus and Myonnesus and the army crossed into Asia and won a battle at Magnesia in 189. The fleet fought to open the way transported men and war material brought out from home needed supplies carried intelligence to and from home and held the line of retreat; it was essential for conquest and to hold places won.

The Romans were not satisfied with affairs in the Greek peninsula at the time they won foot-hold in Asia 189 B C, and in 168 at Pydna in Macedonia won a decisive victory and by the treaty following Macedonia was divided into 4 districts: commerce and inter-marriage of persons between these were made unlawful, certain payments required to be made to Rome, oppressive laws as to mining promulgated, and Macedonians were, "Prohibited from cutting ship-timber themselves or suffering others to cut it."[5] This must have been to prevent ship-building in Greece where no ship-timber grew and where reliance for this had long been in the region north of Greece proper.

UNIVERSAL PIRACY FOLLOWS ROME'S DESTRUCTION OF SHIPS.

In 200 years Rome acquired control of all Mediterranean lands; her rule extended east to Syria and Egypt and west to Gaul Spain and Britain. Everywhere, moved by appreciation of their usefulness and desire to retain sea-traffic in her own hands, she destroyed ships. She failed however to foresee all results of this: seamen thrown out of employment turned to piracy with such craft as could be had; there were no long-ships other than those in the service of Rome of which to form police-fleets and these were until the ending of the Civil Wars of Rome employed in these and were afterward suffered largely to disappear. It resulted that piracy dominated the Mediterranean; "Imports in general ceased coming into Rome" we are told,[6] "And the corn supply was shut off entirely." Another historian says,[7] "The number of the pirates' galleys amounted to 1000 and the cities they were masters of to 400. xx They not only insulted the Romans at sea but infested the great roads on land. xx When they took a prisoner xx they let a ladder down into the sea and bade him go in peace and if he refused to do it they pushed him off the deck and drowned him. Their power extended over the whole Tuscan Sea so

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[5] Livy 45, 29.

[6] Dio Rom Hist Foster ed p 16 and foll'g v 2; Dio wrote about 200 A D.

[7] Plutarch Pompey v 4 pp 66–70 Langhorne ed for this and other passages quoted: Plutarch wrote about 75 A D.

that the Romans found their trade and navigation entirely cut off; the consequence of which was that their markets were not supplied and they had reason to apprehend a famine. This at last put them upon sending Pompey to clear the sea of pirates. Gabinus one of Pompey's most intimate friends proposed the decree which created him not admiral but monarch and invested him with absolute power. The decree gave him the empire of the sea as far as the Pillars of Hercules and of the land for 400 furlongs from the coast. xx He was to take xx what money he pleased. xx xx He was empowered to fit out 500 ships and to raise an army of 120000 foot and 5000 horse. Twenty-four senators xx were appointed his lieutenants."

The date of the decree is 67 B C: Plutarch continues as to Pompey's operations, "The price of provisions fell immediately xx. First he resolved to clear the Tuscan Sea and the coasts of Africa Sardinia Corsica and Sicily xx which he effected in 40 days. xx Still there remained many pirates xx who manned their ships and waited for Pompey at Coracesium in Cilicia.[8] A great battle ensued and the pirates were defeated xx. Thus the war was finished within 3 months at the furthest. Besides other vessels Pompey took 90 ships with beaks of brass xx." Plutarch writes also, "The pirate fleets were not only extremely well manned supplied with skilful pilots and fitted for their business by lightness and celerity, but there was a parade of vanity about them more mortifying than their strength in gilded sterns purple canopies and plated oars xx. Music resounded and drunken revels were exhibited on every coast xx." Dio writes,[9] "They robbed and harried first and foremost sailors, for such not even the winter season was safe. The pirates through daring and practice and success were now showing absolute fearlessness in their seamanship."

The food of Rome came principally over-sea and its amount and the number of ships required to bring it are estimated below.[1] The ships carrying food were round-ships though long-ships were necessary to keep trade-routes clear of enemies and pirates. Pompey's operations are neither the first nor last we hear of policing trade-routes; the city of Cumæ in the south of Italy had a fleet at sea in 490 B C,[2] "To defend

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[8] East Side Gulf of Adalia: other battles here are mentioned n 1 p 160.

[9] Place cited n 6 preceding p.

[1] Pp 223–4.

[2] Rom Antiq Hallicarnassensis Spelman trans v 2 pp 94–5. In this work it is stated ships of 75 tons ascended the Tiber to Rome or nearly so far while larger ones lay below and that the mouth of the river was fortified from an early date: Mommsen writes, "Rome was indeed from the first a maritime city."

their vessels." The pirates were soon abroad again for Rome's food-supply was threatened in 10 A D,[3] and during the reign of Tiberius 14–37 A D, "The Roman people are daily exposed to the mercy of uncertain seas and tempests" writes Tacitus.[4] At this time Rome established 3 police fleets[5] which were maintained for many years, being mentioned by the Roman writer Vegetius in 375 A D.[6] They however failed to keep trade-routes open for riots occurred in Rome in 350–400 A D because corn-ships did not come in.[7] Fleets to police the seas are pre-historic: the one in 490 B C south of Italy is not the earliest of which record exists; Thucydides writes [8] that Minos King of Crete about 1300 B C acquired a navy for the better coming in of his revenues. Since the number of ships and value of cargoes must be considerable before police fleets are established this is strong proof of the antiquity of sea-borne commerce.

REMARKS OF TECHNICAL CHARACTER FOR THE MOST PART DETACHED FOUND IN HISTORIES OF GREECE AND ROME.

There are passages in Greek and Roman writings belonging in the 500 years preceding the Christian era which have not yet been noted. An attempt was made to define the distance between ships when in line-of-battle and that at which hostile fleets formed for battle.[9] The battle line was nearly always single though one case is recorded when more than one line was formed and for this the reason is given; [1] also the circumstances of fleet actions have been gone over: they consisted in a period during which ships approached at speed bow to bow when missile arms were employed followed by collision or contact when hand-to-hand fighting ensued. Or ships passed through the enemy's line breaking oars or losing their own or through the open water between ends of oars; and during this time a discharge of missiles went on: ships that went through the opposed line turned 180° to attack the stern but there is nowhere suggestion of

[3] Dio's Rome Foster ed v 4 p 194.

[4] Annals bk 3, 54; Bohn ed in 2 vs p 140 v 1.

[5] Tacitus v 1 p 157 ed cited bk 4, 5, "Italy was guarded by 2 fleets in the 2 seas one at Misenum one at Ravenna and the nearest coast of Gaul by galleys taken by Augustus at the Battle of Actium and sent ably manned to Forojulium" (Frejus): below p 224 as to these fleets.

[6] Mil Inst Clarke trans p 196.

[7] Amm Marcellinus Bohn bk 19 ch 10.

[8] Bk 1, 4.

[9] Above p 99.

[1] Above p 147.

their backing when through the enemy and attacking by or from their own stern.[2] As to these things authors are in agreement; Sophocles Herodotus Æschylus Aristophanes Thucydides Xenophon Polybius Appian Diodorus Julias Cæsar and others—they all agree. Even what Homer says of war on the sea, though not as to ships contending with ships, is in accord: further there is little change in the Mediterranean during mediæval days and the ways of the Northmen are the same.

BINDING SHIPS TOGETHER FOR BATTLE.

There is record that ships were bound to each other by ropes or chains before battles in both ancient and mediæval days in the Mediterranean and by the Northmen. Historians say this was done to prevent the enemy passing through the line [3] and there is reason to believe that it may have been to prevent ships from deserting. Polybius mentions binding ships for a battle between Illyrians and Greeks in 200 B C; writing,[4] "The Illyrians having tied their vessels 4 and 4 together came on to the engagement with much seeming negligence and even presented their sides to the enemy as if to aid them in their attack and render it more effectual. But no sooner were they grappled close and the beaks of the Achæan ships had fixed them fast to the sides of the vessels that were thus bound together than the Illyrians entered along the decks of the enemy overpowered them by the number of their soldiers took 4 of their quadriremes and sunk one quinquereme to the bottom." Somewhat similar arrangements were made by Scipio in Africa in 202 B C of which Polybius writes,[5] "Scipio found his decked-ships xx not in the least in trim for a sea-fight while the enemy's fleet had been under process of rigging for this purpose the whole winter. He therefore gave up all idea of putting to sea to meet the enemy and accept battle there, but anchoring his decked-ships side by side he moored the transports round them 3 or 4 deep and then sending down the masts and yards he lashed the vessels together firmly by means of these keeping a space between each sufficient to enable light craft to sail in and out."

[2] Pp 140–2 above for Phormio's speech and pp 161 and 165 as to passing through the enemy's line.

[3] Below p 494.

[4] Hampton trans 2d ed 1761 v 1 p 181; bk 1, ch 1: see below pp 375–76.

[5] Same ed bk 14, 10: also Appian 1692 p 9. Appian lived 125 A D. P 41 Appian gives description of ancient Carthage; there were radial docks to shelter 220 ships-of-war under cover with colonnades and admiral's house at center of docks. Frontispiece and p 387 Smith's Carthage and pp 290–93 Church's Carthage have plans of these docks which must be drawn by Appian's description. See also Capomanes Antiquedad Mar Rep de Cartago.

There was a battle near the Hawaiian Islands in modern days in which ships were lashed together; it is called the Battle of Hooroto and its story is as follows,[6] " One fleet had 90 vessels each 120 feet long. These were lashed in a line stems to sterns. This they called *api* and adopt it to prevent breaking the line or flying. The opposing fleet was lashed in the same way xx. They paddled out to sea the warriors occupying the platforms raised xx. At a distance stones were thrown on a nearer approach light spears or javelins were hurled until they came alongside, when they fought with the most obstinate fury." The moderns have lost the art of throwing except those who play ball, but no munition has played a part all over the world and for so long a period as the hand-thrown stone. The raised platforms for warriors at Hooroto are also universal; in a date 3000 years earlier at the Nile-mouth they are found.[7]

HOW SHIPS FOUGHT.

Livy writes of a battle off the south of Italy in 210 B C between fleets of Rome and the city of Tarentum,[8] " The signal being then given on both sides they charged each other with the beaks of their vessels and none during the conflict either drew back his own ship or suffered his adversary to go clear of him, and thus the engagement became so close that they fought not only with missile arms but with swords and almost hand-to-hand. The prows being lashed together remained unmoved xx. The ships were crowded so that xx scarcely any weapon fell without effect into the sea." To show how close Livy deemed the likeness between land and sea-battles his description of a land battle is given; " When the enemy had scarce come over the rampart," he writes,[9] " The Romans discharged their javelins at them, the Spaniards stooped to avoid the weapons thrown then rose to discharge their own, when the Romans in close array had received these on their conjoined shields in their accustomed manner they immediately closed foot to foot and had recourse to their swords to determine the contest." Actions on sea and land differed little: 2 lines approached using missiles and when these met the men fought with sword and shield, holding the line depended on personal strength and activity and skill

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6 Ellis Polynesian Researches, p 241 v 1: Ellis wrote about 1830 and says he had the story from men who were in the battle.

7 Above p 31: Homer also mentions these; above p 112.

8 Bk 26, 29: this battle affected the fortunes of Hannibal in Italy. Ships are here described as lashed only to the enemy; not to each other.

9 Bk 28, 2.

with weapons: if the line gave way at any point the enemy poured through and attacked in rear. It was almost the same on land and sea. In telling of a battle at sea Livy wrote also,[1] "The bravery of the soldiers generally decides battles," and Lucan 50 years after Livy wrote,[2] "In a sea-fight the sword effects the most. Each man stands on the bulwarks of his own ship facing the full blows of the enemy and none fall slain in their own vessels."

ACTIONS PARTLY ON LAND AND PARTLY IN SHIPS.

There were battles partly on land and partly on the water as long as war-ships depended on oars. Marathon and Ægospotamos were fought in this way and the fleets of the Northmen though independently developed were often in similar contests. There was an interesting case of this at Pylus in the south of Greece in 425 B C. Pylus is now Navarino and here in 1827 a fleet of English French and Russian ships destroyed the Turkish fleet freeing Greece from Turkish rule and ending the power of the Turks at sea; for which reasons the battle has been called one of the decisive ones of history. The bay was also scene of hostilities of fleets of Venice and Genoa in 1354.[3]

In telling of the operations in the year 425 B C referred to the Athenians being onshore with ships, "Drawn up under the fortifications xx and enclosed in a stockade" and the enemy Spartans rowing in to force a landing Thucydides says the leader of the Athenians addressed his men as follows,[4] "I call on you Athenians as you are and knowing from experience the nature of a naval descent on the coast of others namely that if a man should stand his ground and not retreat for fear of the roaring surf and the terrors of the ship sailing to shore he would never be driven back xx": of the attacking fleet he says, "Brasidas being captain of a triere and seeing that in consequence of the difficulty of the position the captains and steersmen xx shrunk back and were cautious of their vessels he shouted out and said it was not right to be chary of timbers xx but he bade them shiver their vessels to force a landing xx. Having compelled his own steersman to run the ship ashore he stepped on the gang-board and was endeavoring to land when he was cut down by the Athenians. He fell into the ship's bow his shield slipped from round his arm into the

1 Above p 165.
2 Pharsalia Bohn p 117, bk 3; Lucan died 65 A D.
3 Below p 479: thus there were battles here in 425 B C and 1354 and 1827 A D.
4 Bk 4, 9 and foll'g: see above p 143.

sea and on its being thrown ashore the Athenians picked it up and afterwards used it for a trophy." The ships are coming in bows-on while the Athenian ships " Drawn up under the fortifications " have their bows to seaward; and it being intended to remain considerable time are drawn well onshore beyond the reach of the surf. It will be noted that as Brasidas' shield floated it was made of wood or skin, not metal.

In 375 B C a Greek fleet of 100 ships landed in Phenicia and we have the following description of this by Polyænus,[5] " Iphicrates as he approached the Phenician coast which was flat and muddy found the enemy drawn up to receive him. Observing their position he ordered the masters to form a line and go to the shore and at a signal given to drop their anchors and the soldiers every one immediately to take up his arms and each by his respective thole jump into the sea. As soon as Iphicrates supposed the sea to be shallow enough for his purpose he gave the signal. The vessels instantly dropped anchor the soldiers quitted them in perfect order and under cover of their shields advanced to the shore. The enemy intimidated by the order of their march abandoned themselves to flight xx." It seems almost incredible that landing in face of an enemy was as well-ordered as represented but there is no doubt landings and embarkations were frequent and performed with ease and certainness.[6]

A curious battle occurred on the coast of Syria in 217 B C; troops being in line-of-battle perpendicular to the shore and fleets in line with the troops. Antiochus King of Syria was advancing south along the shore of Syria accompanied by a fleet; Polybius writes,[7] " He advanced with the

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[5] Stratagems of War Shepherd trans 2d ed 1790 p 119. See below pp 405, 430, as to landings during the Crusades; the ships of the later day drew more water and the men leaped into deeper water but otherwise circumstances are the same. Polyænus' date is 180 A D.

[6] See flight and embarking of Persian army at Marathon, above p 119; Cæsar's Com Civil War 2, 43 and 4, 20; Alex War ch 8 p 386, Bell ed, 1908. Æschylus Suppliants p 435 Bohn ed line 694 writes of a landing in peace time,

> " No speedy task the manage of a fleet
> Nor yet to fix the moorings nor ashore
> Safely to bring the stern-ropes; nor at once
> Are shepherds of swift galleys wont to trust
> Their anchor hold; x x
> x x x
> Trust me, the army will not disembark
> Till in their moorings safe the vessels ride."

See above p 17.

[7] Hampton's trans 3d ed v 2 p 278; bk 5 ch 6: see Abrege Comm Folard Hist de Polybe 1754 v 3 p 99 for illustr of the battle and comment. Polybius born 13 years after the battle expresses no surprise at its character, but there is no other like it recorded.

rest of his army to attack the enemy in these defiles. The place xx was a narrow ground which lay between Mount Libanus and the sea. xx At the same time Diognetus and Perigenes made all things ready for the engagement having drawn out their fleets very near to shore and formed them into such a disposition that they seemed to make one front with their respective armies. The signal was now made and the battle at once began both on land and sea. Upon the sea because the strength and numbers of the combatants were nearly equal the success was also equal xx:" the land army opposed to Antiochus gave way presently and together with its fleet retreated.

During the siege of Tyre by Alexander the Great in 332 B C we hear of many appliances of war; "engines" mounted on hulks and trieres to assault the city's walls; cutting the cables of Alexander's ships by Tyrian divers and substitution of cables of chain; "close-ships;" etc.[8] This is an early mention of chains for ship-cables but rope-cables though so liable to chafe on the bottom were used until the day of persons now living. The term "close-ship" or "close-fight" was used until modern days;[9] it indicated a ship having sheltered structures on her upper deck to which the crew retired if hard pressed by the enemy after boarding; guns were often mounted in close-fights.

BATTLE RANGE.

The range of missile arms is known with some accuracy[1] but the only statements of ranges in battles are those of Diodorus, who makes Demetrius' fleet charge when 5000 yards distant,[2] thereby showing the standing throwing-machines in ships about 300 B C could not throw so far even at random, and of Cæsar who shows that camps were rarely less than 500 yards apart. The last indicates the range of man-carried throwing-machines, field armies being rarely accompanied by heavier ones, was less than this. The line being formed in front of the camp, the heavy-armed advanced at a run until within effective javelin-range of the advancing enemy, probably not more than 30 yards, halted and threw and resumed the run until foot to foot with the enemy when they drew their swords. The bow and arrow men or cross-bow men whose weapons ranged further

[8] Arrian Hist Rooke trans p 57 2d ed; bk 2, 21.

[9] It might be of interest to examine the word in the original; the translator writing about 1800 naturally renders it "close-ship;" a term used in his day.

[1] Above p 99.

[2] Above p 99.

were handled apart. Cæsar says at Pharsalia his soldiers advanced as usual but Pompey made his men remain stationary: this was a mistake Cæsar says [3] for, "There is a certain impetuosity of spirit and an alacrity implanted in the hearts of all men which is inflamed by a desire to meet the foe." Cæsar's men not understanding the enemy remaining in place halted midway to the line of Pompey, "Again resumed their course and threw their javelins and instantly drew their swords as Cæsar had ordered them. xx Pompey's men xx received our javelins stood our charge and maintained their ranks, and having launched their javelins had recourse to their swords." Cæsar does not say how far apart the lines were before they charged but in another place shows he considers 300 paces too close.[4]

Fighting at very close range has usually occurred and has often been commended. Nelson in whose day gun-sights were very primitive is said to have replied when asked to look at an improved sight that he would do so but, "Hoped British ships would go so close as not to require sights." Nelson was wise as well as brave and had reflected that when the enemy was close he himself was close also. There is possibly advantage in withholding fire and examination might show that he who opens too soon generally loses the battle. The veteran Toledo said when consulted about Lepanto 1571 he believed the first report of a ship's guns should be heard at the same moment as the crash of her beak; [5] we have all heard the men on Bunker Hill were not to fire until they could see the white of the enemy's eyes; and Stonewall Jackson said not many years since, "My opinion is that there ought not to be much firing at-all. My idea is that the best mode of fighting is to reserve your fire till the enemy gets or you get them to close quarters. Then deliver one deadly deliberate fire—and charge." [6]

SIGNALS AND SIGNALLING.

The art of signalling is older than our records. Pliny the commander of a fleet and familiar with ships writes in 77 A D that Sinon, a legendary person of the date of the Trojan War,[7] "Invented the art of corresponding by signals." In the earliest sea-battles we read of sig-

[3] Comm Bell ed 1908 p 367; Civ War bk 3, 92.

[4] P 453 Afr War ch 61.

[5] Below pp 507–8 where fuller citation is given.

[6] Stonewall Jackson Henderson 2 vs v 1 p 199.

[7] Nat Hist bk 7, 57. Signalling is not only very old but has been widely used; see Hist Melanesian Society Rivers v 2 p 534, "The gong in Bismark Archip and Solomon Isl is used to transmit news; messages of complicated character are sent by certain rhythms and variations of sound."

nalling; 2 signals were made when Xerxes' ships fought the Greek fleet at Artemisium in 480 B C one of them *during* the battle.[8] Phormio also made signals during battle: upon meeting the enemy formed like the spokes of a wheel with bows outward and transports within and a squadron of 5 fast ships ready to charge out if occasion offered, he formed in line ahead and began brushing by the bows of enemy's ships, his order being, "Not to attack unless he himself gave the signal." The enemy's ships soon began to fall foul of one another, stationary position being difficult to maintain; "At that moment he gave the signal and his ships attacked." [9]

We do not know the character of the flags or signs by which the Greeks made signals. Ships were distinguished by scrolls on their sterns not by flags as now.[1] Diodorus says that in a fleet action near Mitylene in 406 B C the signal for battle was hoisting a purple flag and in another off Salamis in the Island of Cyprus in 306 B C it was, "Lifting up a golden target visible to the whole fleet." [2] It was noted above that Lysander used the hoisting of a shield as a signal at the battle of Ægos-potamos.[3] There is another very interesting case recorded: a battle is in progress in 190 B C off the south of Asia Minor; the fleets are in separated groups and our authority writes of the commander of one of these,[4] "He would have surrounded and over-powered his adversary had not the signal for a dispersed fleet collecting together again been displayed from the commander-in-chief's ship." [5] This was much the same as calling a hound off a wounded quarry. The signal was probably prearranged; in a book of signals and made with a single sign or flag. Hannibal commanded one of the fleets in this battle.[6] He commanded in at least 2 sea-battles and before one, "He called the officers of his ship together xx and directed them all to make an attack on the single ship of King Eumenes (commanding in person) and to be content with simply defending themselves against others." [7] It is interesting to note that

[8] Above p 122: see Herod 7, 128 for another case.

[9] Above p 140.

[1] Above p 126. At present war-ships look much alike but persons in fleets know them and their steam-whistles or sirens.

[2] Booth trans p 550 v 1; p 462 v 2.

[3] P 149.

[4] Livy 37, 33: this was near Phaselis; see n 1 p 160 above for other battles near.

[5] See just below as to Nelson's being signalled at Copenhagen to come out.

[6] Above p 160.

[7] Justin Nepos and Eutropius Bohn pp 423–4: in Nepos' writings a Roman of 50 B C: see also above p 100 n 9.

Nelson in his Memorandum before Trafalgar gave almost identical direction; every effort must be made to capture the enemy's commander-in-chief. Rarely have signals been made and obeyed in course of battles: the writer is not aware how this stands in the recent war, but no doubt signals were made during manœuvring for ships were in rapid motion. Even if read they are liable to be misunderstood; Lord Howe after his ships put helms up to steer for the intervals in the French fleet at the Battle of the First of June is said to have closed his signal-book, regarding his functions as ended; it remained only for captains to do as ordered. At Copenhagen the commander-in-chief, being at some distance and thinking Nelson, in immediate command of the ships actually engaged, worsted, generously signalled him to come out, but Nelson pretended he could not see the signal. The case of our commander of a group was not unlike Nelson's but he obeyed the signal; many would think more of him if he had not done so provided the fates were kind to him afterward. Our business is not however with such considerations; we note only that during battle an unwelcome signal was made understood and obeyed.

In regard to communicating intelligence of general or complicated character by signal this also was done when the records begin; methods like ours being in use. Herodotus tells that when Xerxes invaded Greece, "When the Greeks stationed at Artemisium learned what had happened by fire-signals from Sciathus xx." [8] The distance is about 20 miles and the message of character impossible to arrange for in advance; in other words it must have been sent by phrases by single words or words spelled letter by letter. Polybius is clear about signals and describes arrangements by which any message whatever may be made by spelling it out. He says Æneas Tacticus [9] 375 B C made improvements, describes these and says they, "Still fell very far short of what was wanted;" then goes on to describe in detail improvements of his own. The work of Æneas is mentioned above but what he wrote of signals is not in the edition accessible [1] though there is no doubt that at early date any message could be sent by signal.

[8] Bk 7, 182: See Xen Hell bk 6, 2, 31–36 Dakyns trans for a case in 373 B C when signals which could not have been prearranged were transmitted.

[9] Bk 10, 43–7. Sir Wm Thompson well-known to seamen writes the modern method of signalling by long and short dashes is, "In military operations of the 19th century a return to a kind of telegraph due it seems originally to Æneas a Greek writer on tactics and improved by Polybius:" Nature Ser Pop Lectures Sir Wm Thompson v 3 Naval Aff. See Rollins' Anc Hist bk 18, 6.

[1] Above p 49 n 5.

THE CORVUS OR BOARDING-BRIDGE.[2]

The corvus was a bridge or gangway hinged to the foot of a mast and triced up to it. There was a spike under its upper or outer end which when the corvus was dropped was driven into the enemy's deck; ships being thus fastened together boarders advanced over the bridge and the sea-battle became like a land-battle. The corvus attained notoriety because used at Mylæ in 260 B C. Polybius says, " Some-one suggested it " and describes it.[3] The boarding-bridge like many other appliances defies attempt to learn its origin being mentioned in the earliest accounts of sea-battles. It was used at Mycale 479 B C for Herodotus writes of this,[4] " The Greeks made themselves ready for a sea-fight by the preparation of boarding-bridges." There is another early account of them; Vitruvius 30 B C says Diades, who fought under Alexander the Great 325 B C, promised to describe boarding-bridges but failed to do so.[5]

A SHIP OF SEVEN BANKS AT MYLÆ.

Polybius says at Mylæ 260 B C the Carthaginian commander-in-chief,[6] " Was onboard a ship with 7 banks of oars which had once belonged to King Pyrrhus." Pyrrhus was King of Epirus and crossed the Adriatic into Italy and Sicily 281 B C bringing an army with a number of elephants, beasts never before seen in Italy. As no historian says anything about differences between this ship and those in Roman and Carthaginian fleets it follows that they were alike. She was a large ship else the Carthaginian commander-in-chief would not have taken her for flag-ship but beyond this was like other ships.

THE BATTLE OF ECNOMUS.

Ecnomus is a promontory in Sicily 80 miles west from its southeast corner. Here a Roman fleet encountered the Carthaginians in the early

[2] Above p 150: for use of these by Peter the Great see p 382 below.

[3] Bk 1, 22: Plyb was born 40 years after the end of the 1st Punic War. Florus of 100 A D describes Mylæ at greater length than Polyb; see Sallust Florus and Paterculus Bohn p 316: on p 319 he describes Bat Ecnomus to which we come presently, saying the Roman fleet, " Wheeled about by its oars like cavalry in battle by their reins."

[4] Bk 9, 98. The Greek word is *apobathra,* which means *a landing;* the verb *apobain* means to *go* or *come out.* Ships both long and round probably used apobathras.

[5] Dix Livres etc bk 10 ch 19; Machines of Attack: Vitruvius explains astrolabes clocks logs and other things of interest in ships: he is said to have served in the army of Cæsar as maker of balistas etc.

[6] Bk 1, 23. As this vessel came with Pyrrhus in 281 she was at least 21 years old at Mylæ.

part of the First Punic War and defeated it.[7] The fleets were nearly equal there being in the two 660 quinqueremes, 5-oars. Polybius says there were 300 rowers and 120 heavy-armed in each; a total of 277200 in the 2 fleets. The Romans he says,[8] "Had only 2 ships with 6 banks of oars." The Roman fleet again used the corvus forming east of the Carthaginians in an isosceles triangle with apex toward the enemy; the enemy being in a single straight line with left flank near Ecnomus, hoping with the right or seaward flank to envelop the Roman fleet. Of results Polybius says, "24 Roman ships were destroyed over 30 Carthaginians. Not a single Roman ship was captured with its crew 64 Carthaginian were so taken. After the battle the Romans took in a fresh supply of victuals repaired and refitted the ships they had captured xx and then put to sea with a view of continuing their voyage to Libya xx. Here they disembarked beached their ships dug a trench and constructed a stockade around them."[9]

THE BATTLE OF DREPANUM.

Off Drepanum now called Trapani in the west of Sicily a Roman fleet was defeated by Carthaginians in 249. The Romans were near the land and Carthaginians to seaward; both fleets in single line abreast. Polybius writes,[1] "The Carthaginians derived no small advantage from having ranged their fleet on the side of the open sea. Whenever closely pressed they had room to retreat xx. If the Romans advanced too far in pursuit they then turned suddenly on them and making their attack with vigor and agility, now on the sides and sometimes on the stern, sunk many Roman vessels xx. When any Carthaginian ship seemed about to be taken her consorts advanced and ranged fresh ships in the stern of the pursuers thus rescuing their friends from danger xx. When pressed the Romans had no room to retreat for every vessel that retired before the enemy either stuck on the sands or was dashed against the shore. As the Roman ships were also heavy and their rowers destitute of skill they were quite deprived of

7 Above p 151.

8 Bk 1, 26–29. In bk 1, 63, Polybius refers to, "The superior size of the quinqueremes compared with the triremes employed by the Persians against the Greeks and again by the Athenians and Lacedæmonians in their wars with each other, xx"; but Serre thinks quinqueremes could not have been as large as Polybius says; Mar de Guerre v 1 pp 37, 41, 67: above p 160, note 7.

9 Serre v 1 p 53 gives displacement or weight of the quinquereme at 300 tons. See above p 160 for another case of hauling ships of this rating onshore.

1 Bk 1, 4; p 109 v 1 Hampton trans in 2 vs, 1761.

the advantage, the *greatest that is known in naval battles of sailing through the fleet of the enemy and attacking in stern the ships that are already engaged with the enemy.*" This battle and the one off Ecnomus are dwelt on because it is only of these Polybius gives tactical details. His description of Drepanum is one of the most interesting and full we have.

STEERING A RANGE.

Seamen when land is in sight and they wish to keep the ship closely to one line select 2 points on shore at a distance from one another and in line and steer so as to keep them in line. This they call steering a range and we find it in the days we have come to: Polybius writes in one place,[2] "A man of rank among the Carthaginians Annibal surnamed the Rhodian engaged to sail into the harbor, and when he had seen the condition of the city to return again to Carthage with an account of all they desired to know xx. The Rhodian was encouraged chiefly in this bold attempt by his perfect knowledge of the coast which taught him in what manner he might best avoid the banks of sand that lay at the entrance to the harbor. For this purpose having first gained the open sea he from thence held on his course xx taking care to keep a certain tower that stood on the shore in a line so direct and even with his prow that it covered from his view the other towers. xx The example of the Rhodian was in a short time followed by many others." The Rhodian's ship was a quinquereme and when captured as she finally was the Romans built a fleet of 200 on her model.[3]

THE SECOND PUNIC WAR, 218–202 B C.

There remain to note regarding this war 3 passages, all in Livy. The first belongs in 217 B C and is as follows,[4] "Hasdrubal xx giving the command of the fleet of 40 ships to Himilco set out from New Carthage marching his army along the shore while the fleet sailed at a small distance from the land so that he was prepared to fight on either element whenever the enemy should come his way; Scipio with a fleet of 35 sail proceeded to meet

[2] Bk 1 ch 4, pp 101–3 v cited note next above. The tale is of the port of Lilybæum now Marsala in the west of Sicily, whence comes the wine so many have enjoyed.

[3] P 121 v Polyb cited 2d note above.

[4] Bk 22, 19: Livy died 18 A D 220 years after the end of the 2d Pun War. New Carthage was founded by Hasdrubal 242 B C; it is now Carthagena. From here to the Iberus is 180 miles. See pp 182 and 184 as to the other passages here alluded to.

him. xx He arrived at an harbor xx and despatching thence 2 Massilian scout-boats learned that the Carthaginian fleet lay at the mouth of the Iberus and that their camp was pitched on the bank. Intending xx to overpower the enemy while unprovided and off their guard he weighed anchor and advanced toward them; xx the Roman fleet was descried and notice given to Hasdrubal from a watch-tower onshore somewhat earlier than the alarm reached the ships where they had not heard the dashing of oars nor any other noise usually accompanying a fleet and the capes shut out the enemy from their view. On a sudden while they were rambling about the shore or sitting quietly in their tents expecting nothing less than the approach of an enemy or a fight on that day, several horsemen despatched by Hasdrubal came one after another with orders to go onboard instantly and get ready their arms for the Roman fleet was just at the mouth of the harbor. These orders the horsemen for the purpose conveyed to every part and presently Hasdrubal himself arrived with the main body of the army. Every place was now filled with noise and tumult the rowers and soldiers hurrying onboard like men making their escape from land rather than going to battle. Scarcely had all got onboard when some having loosed the hawsers at the sterns, were carried foul of their anchors.[5] xx The Romans xx formed their ships in order of battle. The Carthaginians falling into the utmost disorder xx after looking their enemy in the face rather than engaging him in fight went about and fled up the river or xx drove their ships ashore wherever they could and made their escape, some with their arms and some without them to their friends who were drawn up in a line onshore. In the first encounter 2 Carthaginian ships were taken and 4 sunk. The Romans notwithstanding that the land was possessed by the enemy and that they saw a line of troops under arms stretched along the whole shore yet without hesitation they pursued the dismayed fleet and all the ships which had either shattered their prows by striking against the shore or stuck their keels fast in the bottom they fastened to their sterns and towed out to sea. Out of 40 ships they took

[5] Serre puts the displacement of these vessels at 300 tons their draft at 5 ft and the height of their rail from the water 9 ft; pp 53, 41, v 1 Mar de Guerre. They were moored as usual with an anchor to seaward and sterns drawn by a hawser to the shore. The hawsers being loosed the ships might foul their anchors when being lightly built they would be in danger. It would not be easy to wade and swim to the stern of a vessel in 5 or 6 ft of water and climb onboard over a rail 9 feet above the water: see above p 164 for another embarkation in ships of the same class 20 years afterwards.

25. The most brilliant circumstance was that xx they were masters of the sea along the whole coast."

A FLEET TRANSPORTS AN ARMY OVER-SEAS.

The second passage alluded to above regarding the Second Punic War is Livy's description of the crossing from Sicily to Africa of the army which defeated Hannibal at Zama. This is in part as follows;[6] being in Sicily Scipio, "Sent orders to all the sea-coasts that the ships-of-burden should be all seized and brought to Lilybæum. When the whole number of troops and ships in Sicily had assembled at Lilybæum neither could the city contain the multitude of men nor the harbor the ships. xx Authors differ widely with regard to the number of men carried over to Africa.[7] In some I find 10000 foot and 2200 horse; in others 16000 foot and 1600 horse; while others augment the numbers to more than one-half and assert that more than 35000 horse and foot were put onboard the ships. Some have not stated the numbers and among these as the matter is uncertain I choose to place myself."

"Scipio took upon himself the charge of making the men embark in a regular manner without confusion. The seamen who had been embarked before were kept in order onboard the ships by Caius Lælius who had the command of the fleet. The charge of shipping the stores was allotted to the prætor. There was shipped a quantity of food sufficient for 45 days as much of it ready dressed as would serve for 15 days. When they were all embarked he sent round boats to bring the pilots masters and 2 soldiers out of each ship to the Forum to receive orders. When they were assembled there he first inquired of them whether they had put water onboard for men and cattle for as many days as they had corn: they answered that there was water onboard for 45 days. He then charged the soldiers that attentive to their duty they should behave themselves quietly that the seamen might not be disturbed by noise but might perform their business without interruption; informed them that he with 20 ships-of-war would protect the transports of the right division and Caius Lælius commander of the fleet with the same number those on the left; that the ships-of-war would carry each a single light the transports 2 and that the signal by night onboard the ship of the commander-in-chief would consist of 3 lights. xx Having issued these orders he commanded them to return to

[6] Bk 29, 24–28.

[7] The crossing was 204 B C 2 years before Zama.

their ships and on the signal being given next day with the favor of the gods to set sail. xx " [8]

" Besides 50 ships-of-war Scipio conveyed his troops in about 400 transports. xx On all occasions he had publicly declared that his intention in passing over was to draw Hannibal away from Italy and finish the war in Africa. As soon as the next day appeared a herald having commanded silence Scipio in the admiral's ship spoke thus, 'Ye gods and goddesses xx lend you favorable aid to all our measures and further them by happy advancements, bring us all home safe and unhurt victorious over our conquered foes decorated with spoils laden with booty and exulting in triumph xx.' After the prayer he threw into the sea according to custom the raw entrails of a victim which had been slain and gave by a trumpet the signal for sailing " ; not by a visual signal.

The ships were both round and long anchored off from shore. Round-ships being deep and heavy always anchored thus and that in this case the long-ships were anchored off is shown by the boats sent to bring the pilots masters and soldiers out of each ship to the Forum, for if the ships had lain with stern drawn to the beach with a rope they would have jumped from the vessels and presented themselves at the Forum in wet garments. How were the soldiers horses water and food for 45 days put into the ships? Livy does not allude to this but rafts must have been used and on reaching Africa the men jumped into the water when ships touched the beach and horses were shoved overboard. Provisions and water for 45 days, not inconsiderable in volume and weight, were taken in case of opposition to landing, and cooked food for 15 to cover delays at sea and something over. The fleet had a little less than 150 miles to go as we shall see presently was not opposed by force and had favorable weather. The army was not in the ships more than 2 or 3 days: it was a well-planned and successful operation.

To resume Livy's narrative: " The wind being favorable and blowing

[8] The use of distinguishing lights in fleets is very old: an Athenian admiral in 390 B C, "Led the way in the darkness showing the customary light to prevent his fleet straggling;" Xen Hell bk 5, 1, 7–10; in 300 B C an admiral, "Went his way giving orders to the captain of every vessel to follow his admiral's lanthorn", Diodorus, Booth trans v 2 p 471. The use of lamps in ancient days was common as the numbers found show but exactly how lights were carried in ships, not suffered to go out, how shrouded, is not mentioned. Not many years ago when the powder-magazine was opened lights were put out and to keep means to light up again a lighted lantern placed in the manger, the enclosed space at the hawse-pipes to catch water and mud brought in by the cables. Yet in battle at night "battle lanterns" were lighted and hung by each gun, just above where cartridges were passed to the muzzles of guns.

fresh when they set sail they were soon carried out of sight of land but about noon a fog arose which made it difficult for them to keep the ships from running foul of one another. As they advanced into the open sea the wind abated, during the following night the same haziness continued but at the rising of the sun was dispersed and the wind freshened. They were now within sight of land and the pilot told Scipio soon after that, 'Africa was not above 5 miles distant that he saw the promontory of Mercury,[9] and that if he gave orders to steer thither the whole fleet would be immediately in harbor.' Scipio xx gave orders to make sail and steer for another landing place beyond that. They proceeded with the same wind but a fog arising about the same hour as the day before hid the land from their sight and afterwards involved every object in obscurity. They therefore cast anchor lest the ships should either run foul of one another or be driven onshore. At day-break the same wind arising dispersed the fog and discovered all the coast of Africa. Scipio inquiring the name of the nearest promontory and being told it was called Cape Fair [1] said, 'The omen is pleasing steer the ships thither.' Thither the fleet ran down and all the forces were disembarked.[2] I have followed the accounts of very many Greek and Latin authors that the voyage was prosperous without danger or confusion. xx When the troops were landed the Romans formed their camp on the nearest rising ground."

THE SENATE IN CARTHAGE IN 206 ORDERS AN ADMIRAL AT CADIZ TO GO TO HANNIBAL'S AID: THE ADMIRAL SAILS ATTACKS A STRONG PLACE BARELY ESCAPES WITH HIS FLEET AND WINTERS IN THE BALEARIC ISLANDS.

The third passage in Livy alluded to includes several points of interest. In 206 the year following the defeat of the Carthaginian army at the Metaurus he says,[3] " Information was brought Mago from Carthage that the Senate ordered him to carry over to Italy the fleet which he had at Gades and xx to form a junction with Hannibal and not to suffer the

[9] The prom of Mercury or Hermæum is the east headland of the great bay on which on its western side Carthage and Utica were situated. The fleet is 24 hours out and has come 75 miles a good run for 450 sail. From Hermæum by land to Carthage or Utica is 100 or 150 miles; as will be seen presently Scipio kept on in the ships for Utica distant by sea 50 miles and landed there.

[1] A translation of Pulchrum Promontory, the western headland of Bay of Carthage: the fleet has made good 50 miles west in 24 hours being anchored for a time.

[2] The end of Pulchrum prom is 12 miles north of Utica.

[3] Bk 28, 36–37. Mago was a Carthaginian general: this passage is cited p 155 above.

war to sink into languor xx. Money to answer this purpose was brought to Mago from Carthage and he extorted as much as he could from the people of Gades plundering not only their treasury but their temples and compelling them all to bring in their private properties of gold and silver to the public treasury.[4] As he sailed along the coast of Spain he landed his men not far from New Carthage [5] and having ravaged the lands adjoining brought up his fleet from thence to the city, where having kept his soldiers onboard the ships during the day he landed them in the night and led them on to that part of the wall xx supposing that the city was not secured by a strong garrison xx. But the garrison was drawn up under arms withinside the gate which looks toward the basin and the sea. When the enemy rushing on in a tumultuous manner with crowds of seamen mixed with the soldiers advanced to the wall with more noise than strength the Romans suddenly throwing open the gate rushed forth with a shout and having disordered and repulsed the enemy at the first onset and discharge of their darts they pursued them with great slaughter all the way to the shore, nor would one of them have survived the battle and pursuit had not the ships coming close to the shore received them as they fled in dismay. Those onboard the ships also were not without their share of the confusion while they were drawing up the ladders lest the enemy should force in along with their own men and cut away their cables and anchors to avoid the delay in weighing them. Many in attempting to swim to the ships as they could not in the dark distinguish whither they ought to direct their course or what to avoid met a miserable death.[6] Next day when the fleet had fled back to the ocean from whence it came there were found xx 800 men slain and 2000 stands of arms lost. When Mago returned to Gades he found the gates shut against him on which he put in with his fleet at Cimbis [7] a place not far from Gades xx. From thence he sailed over to the Island of Pityusa about 100 miles from the continent inhabited at that time by Carthaginians, where the fleet was received in a friendly manner

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[4] Money was more easily sent than stores and sufficed to maintain the fleet as the men bought food onshore with money paid them.

[5] Now Carthagena; from Cadiz to Carthagena is 350 miles by sea; Livy does not say how long the passage took nor how many ships there were.

[6] The tale is like Herodotus' of Marathon; but the ships are of greater draft. A ladder by which to embark and disembark is very old: see illustr anc craft in Torr's Anc Ships and Odyssey Butcher and Lang prose trans 1883 p 233, "I slid down the smooth ladder at the stern xx."

[7] South 20 miles from Cadiz.

and supplied not only with an abundance of provisions but with a re-inforcement of young men and arms."

SHIPS DRIVEN OFF BY SLUNG STONES: HOW PORT MAHON CAME BY ITS NAME.

Livy continues; "Emboldened by these succors the Carthaginians sailed thence to the Balearic Islands about 50 miles distant.[8] There are 2 of the Baleares one larger than the other and more powerful in men and arms which also has a harbor where he believed he might spend the winter commodiously as it was now the latter end of autumn.[9] But here his fleet met with opposition as violent as if the inhabitants of that island had been Romans. As they now mostly use slings so at that time these were their only weapons and no single person of any other nation excels so much in the skilful use of them as the Baleareans universally excel all others. Such a quantity therefore of stones was poured like the thickest hail on the fleet as it approached the land that not daring to enter the harbor the Carthaginians tacked about to the main.[1] They then passed over to the smaller of the Baleares which is fertile in soil but not equally strong in men and arms. Here they landed and pitched their camp in a strong post over the harbor [2] taking possession of the city and country without a contest; then having enlisted 2000 auxiliaries and sent them to Carthage [3] they hauled their ships onshore. After Mago had departed from the coast of the Ocean the people of Gades surrendered to the Romans."

THE THIRD PUNIC WAR.

This was short and there is little regarding it. The number of engines burned when Carthage was captured has been given,[4] as well as the passage regarding a combat between Roman and Carthaginian vessels reading, "The Romans were forced to receive all the blows of the shot from the Carthaginian engines on their broadsides." [5] A third, that at the siege

[8] This distance and the one previously given are correct. The 2 Baleares are Majorca and Menorca; the first is reached first going east from Pityusa or Ivica.

[9] Has he forgotten Hannibal and his own orders?

[1] I can remember no other statement of the effect of thrown or slung stones on a ship: by the Northmen and others slings were much used; both one and two-handed; see pp 358 n 4, 397 below, 108 above.

[2] Now Port Mahon; named it is said for Mago who wintered there in 206 B C.

[3] The voyage to Italy to aid Hannibal was not longer.

[4] P 157.

[5] P 103 where the quotation is more complete: see also p 621, v i, trans White in 4 vs Eng and Gr text, Loeb Clas Library.

of Carthage, Roman engines, "Cast burning torches sulphur and pots full of flaming pitch," has also been given. There is one other; an allusion to "Carthaginian brigantines gliding along under the oars of the great Roman galleys." [6] As ships using oars in several lines, to keep oar-locks low and oars short would have the lowest line as low as possible, 20–25 inches above the water, there would be scant room for a skiff under the oars unless, as Admiral Serre believes,[7] only the upper line of oars was used in battle.

Admiral Serre translates a passage in Thucydides concerning the fighting in Syracuse harbor in 415 B C as follows, "The Syracusans receiving ram-blows bow to bow as they had already determined to do, broke with the projections they had built at the bows of their vessels the Athenian trieres; the heavy-armed on the catastroma deck also did great execution; but what was most effective was the audacity of the Syracusans in skiffs gliding under the oars of the trieres and fastening themselves to the ships' sides whence they cast darts upon the oarsmen." Others translate this differently: in Dale's translation it reads, "Syracusans who were sailing about in small boats falling close in upon the oars of the enemy's ships sailing up to their sides and thence discharging their darts upon the rowers." [8]

We have thus translations differing more than we could wish of narrations of battles in 415 B C and about 300 years after interesting in regard to whether or not trieres 3-oar vessels manned their lowest oars in battle. It is not to be expected all will agree with Admiral Serre that what Thucydides wrote proves that *skaphe,* the name and its signification is 2500 years old, passed under the oars of the ships-of-the-line, but we shall agree that if they did the lower line of oars, whose looms were 20 inches

[6] Appian trans J D 1692 p 54; see above p 84. This passage is rendered as follows by White p 619 v 1 his trans cited note next preceding, "Loud were the cheers on both sides as they came together xx. During the battle the Carthaginian small boats (the Greek word is *skaphe*) running against the oarage of the Roman ships which were higher stove holes in their sterns and broke off their oars and rudders and damaged them in various ways advancing and retreating nimbly." It follows from Appian's description that fighting lasted from dawn until mid-day; that only toward evening did it end entirely.

[7] Mar de Guerre v 2 p 46, "The presumption of *unireme-rowing* of *trieres* in battle is confirmed by the texts."

[8] The passage is bk 7, 40, Thucydides; Serre's trans is Mar de Guerre v 2 p 46; see also v 1 p 32. If we change the word *oarage* in White's translation to *oars* and suppose his words *which were higher* mean the oars were higher than the rail of the skiffs the sense of his rendering of Appian is the sense of Serre's rendering of Thucydides; and we have reason to suppose the lowest tier of oars was not used in battle.

above the water, were not shipped: we shall agree also that leaving the translations aside it might be very effective to go close in and that it may have been done. How Admiral Serre came to miss the passage in Appian for he does not allude to it is hard to understand, for in his study of early ships little has escaped him. Finally whatever these passages show about rowing they exhibit an interesting feature in the make-up of fleets and their ways; small craft carrying dart-men and stone-throwers and men equipped to injure oars and rudders, including divers we may suppose, were with fleets and were sent into the enemy's line.

THE CIVIL WARS OF ROME.

After Rome acquired power and wealth by conquest and annexation of the islands and shores of the Mediterranean her leading men fell to quarrelling who should control and a confusion during which a number of battles were fought ensued. Parts of these supply interesting information as to ships and their ways but in the fortunes of the contestants we are not concerned. In Plutarch is a tale of a political banquet on ship-board in 39 B C at Misenum near Naples; Mark Antony, Octavius afterwards first Emperor of Rome, and Sextus Pompey son of the great Pompey being present. " Sextus the son of Pompey," Plutarch [9] writes, " Who was then in possession of Sicily had not only made great ravages in Italy but had covered the sea with such a number of piratical vessels under command of Menas and Menecrates that it was no longer safe for other ships to pass. He had been favorable notwithstanding to Antony. It was judged proper therefore to accommodate matters with him and for this purpose a meeting was held at the promontory of Misenum by the mole that runs into the sea. Pompey was attended by his fleet Antony and Octavius by an army of foot. At this interview it was settled that Pompey should keep Sicily and Sardinia on condition he should clear the sea of pirates and send a certain quantity of corn to Rome. When these things were determined they mutually invited each other to supper and it fell to Pompey to give the first entertainment; when Antony asked him where they should sup, ' There,' cried he, pointing to the admiral-ship of 6-oars, ' That is the only patrimonial mansion that is left to Pompey.' And this applied at the same time a sarcasm on Antony who was then in possession of his father's

[9] Antony Langhorne trans v 5 pp 185–6. See also Foster's Dio's Rome v 3 p 198; Rom Hist Paterculus trans J P 1722 p 168; Ferguson Hist xx Roman Emp p 381: Misenum is on west side Bay of Naples.

house. However he entertained them very politely after conducting them over a bridge from the promontory to the ship. During the entertainment while the raillery ran briskly on Antony and Cleopatra Menas came to Pompey and told him secretly that if he would permit him to cut the fasts he would not only make him master of Sicily and Sardinia but of the whole Roman Dominion. Pompey after a moment's deliberation answered he should have done it without consulting him; 'We must now let it alone,' he said, 'For I cannot break my oath of treaty.' The compliment of the entertainment was returned by his guests and Pompey then returned to Sicily."

Pompey's hexireme 6-oar was a long-ship; she lay at a mole that ran into the sea being too large to be conveniently brought to the beach; she was by Admiral Serre's figures [1] about 450 tons displacement 175 feet long and 18 feet beam. She measured probably from keel to upper deck 7 or 8 feet and so was roomy enough to have a comfortable cabin. The men who supped onboard were the most powerful in the world and the banquet was served no doubt at a table regularly set with couches around it after the Roman fashion, the meal being prepared onboard.

Menas who figures here was an old salt. He was a freedman of the elder Pompey was probably poor and had to work for his living and changed sides in the struggles of the day as seemed best: Dio recounts as follows how he saved a fleet on a lee-shore,[2] "Menas being an old hand on the sea foresaw the storm. He stationed his ships out at sea letting them ride with slack anchors some distance off so that the cables should not be stretched and break, then he rowed directly against the wind and in this way no rope was strained and he remained constantly in one position recovering by the use of his oars all the distance lost by the impetus of the wind. The remaining commanders because they had xx as yet had no precise knowledge of nautical matters were cast upon the shore close by and lost many ships."

BATTLE OF ACTIUM.

At the date of this 31 B C there were rivals for power in Rome each with a fleet and army. The records show that ships mounted and used

[1] Mar de Guerre v 1 p 53.

[2] Rom Hist v 3 p 209: the fleet was anchored off Scyllæum at the N end of the Strait of Messina; the year is 38 B C. Dio wrote about 200 A D. Appian of Alex recounts the tale p 252.

standing throwing-machines, *engines* the writers call them, the first mention of which in ships against ships is of 306 B C it will be recalled.[3] At Actium the fleet of Antony was defeated and his army which had watched from shore the contest of the ships was dispersed or surrendered to Octavius. All rivals of the last being thus overcome the Civil Wars came to an end and Octavius became Emperor of Rome.[4] Before Actium occurred Sextus Pompey whose banquet has been mentioned, in efforts to obtain power interfered with food-ships coming to Rome and fleets were sent to drive him away: these fought at the north end of the Strait of Messina in 41 B C off Cumæ, at Mylæ, and Naulochus; the last being in 36 B C. Naulochus was on the north coast of Sicily between the Strait of Messina and Mylæ. In one of these battles a fleet is, " Drawn up with prows facing outward and so offering no safe point of attack; " in another ships, " Used missiles carrying fire." Antony at Actium in a speech to his men told them to, " Inflict wounds with engines from a distance; " and that the enemy's ships, " Would inflict some wounds xx and then retire out of range." [5] Plutarch says of Actium,[6] " There were generally 3 or more of Octavius' ships about one of Antony's assaulting it with pikes javelins and fire-brands while Antony's men out of their wooded towers threw weapons of various kinds from engines." Of Naulochus Appian writes,[7] " The whole gang of rowers began to show their skill xx then followed the flying of missile arms some thrown out of engines some out of hand, as stones javelins arrows fire-brands and flaming darts, the ships ran board and board." The poet Virgil a co-temporary says of Actium, " From their hands flaming balls of tow and from missile-engines the winged steel is flung; " also, " Victorious Antony with barbarian supplies and various

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[3] Above p 99.

[4] Actium was fought at the mouth of what we call Gulf of Arta: here occurred in 435 B C a battle between Corinthian and Corcyrean fleets, a first Actium, Thuc 1, 29; 25 miles north and west Sybota was fought 432 B C; Prevesa between Christian and Turkish fleets led by Andrea Doria and Barbarossa was fought 1538 at the same place as Actium. The Gulf of Corinth where Lepanto occurred 1571 is 50 miles south: below pp 504 and foll'g.

[5] The passages are in Dio's Rome Foster ed v 3 pp 208, 209; 219 for the speech of Antony.

[6] Antony Langhorne trans v 2 p 212.

[7] English ed 1692 p 262 Civil Wars. P 258 same recounts, " He gave him so cruel a shock in the bow that he sunk for he opened all his keel xx and the water entering all the lower bank of rowers were drowned; the rest upon planks saved themselves by swimming:" we must believe one of 3 things; the oars were at more than one level, Appian made a mistake, or 3d his translator made one.

troops brings up with him from the nations of the morning and coasts of the Red Sea and Bactra the boundaries of his empire xx all Egypt the Indians Arabs and Sabæans."[8] Florus gives another item of information about Actium saying Antony's ships,[9] "Had from 6 to 9 banks of oars; their *fights* were raised so high with decks and turrets that they resembled castles and cities xx. Augustus' fleet had not in it any ship but from 3 banks of oars to 6 and none above; xx many of these setting upon the enemy and plying them with darts and all sorts of slingings xx scattered them all." We have finally from Orosius, a Spanish priest who lived about 400 A D, a statement of the height of the rail of Antony's ships from the water. It is one of the few statements of definite character and holds out well with other things more or less well established. "Octavius," Orosius wrote,[1] "Had 30 ships and 200 large triremes onboard of which were faring 8 legions,[2] and Antony had 80 ships onboard of which were faring 10 legions; by so many as he had fewer by so much were they better and larger; they were so constructed that they could not be over-loaded with men being 10 feet high above the water."

These passages prove that standing throwing-machines were common in ships at the beginning of the Christian Era. They were great cross-bows not beams swung by weights, that is ships employed horizontal not vertical fire. There exists however no picture of a ship with a throwing-machine set up in her, which leads to the supposition they were mounted only when about to be used; essential parts steel or wood pieces to be bent and hair rope or leathers going with these being carried in the ships and other parts made of wood cut when required.

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[8] Davidson trans Bohn p 298; Virgil died 10 years after Actium. The motley force of Antony furnishes more reasonable cause for his defeat than that often advanced; that he fled away to follow Cleopatra. His ships were mostly from Egypt and larger than those of Octavius.

[9] Rom Hist Eng trans Oxford 1634 bk 4 ch 11: the pass is also p 414 Bohn ed of Sallust Florus and Paterculus: Florus' date is 100 A D. The *fights* are the same as the close-fights of Alexander the Great; see above p 174.

[1] Life Alfred the Great trans Thorpe to Which Is Appended Alfred's Anglo-Saxon Version of Orosius with English Trans Bell 1902 p 465. See also below, p 281.

[2] Taking the legion at 6000 this would be nearly 48000 men: in ancient Greece a trireme was rowed by 200 men, so 200 would call for 40000, which with the 15 or 20 heavy-armed each carried would make the total nearly the same: Antony's 80 ships had complements of 750 and must have been very large for quinqueremes of the Punic Wars carried only 420 in all. According to Admiral Serre's figures the 80 ships of Antony were of average rating hexiremes 6-oars.

CÆSAR'S MILITARY OPERATIONS AT SEA.

Cæsar is not referred to as a commander at sea but no one used the sea more successfully. He crossed the sea to Britain in 55 B C almost a voyage of exploration and again in the year following. Though his rival Pompey had the mastery at sea he crossed the Adriatic with an army in mid-winter, sailing January 4, 48 B C, over-threw Pompey at Pharsalia and went on to Egypt fighting several times at sea. Upon returning to Italy he crossed to Africa with an army in pursuit of one of Pompey's lieutenants again sailing in mid-winter; [3] his soldiers exclaimed, "Whither will this man lead us xx. The gods themselves cannot force the seasons or clear the winter seasons of storms and tempests and it is in this season he would expose us as if he were flying from his enemies rather than pursuing them." [4]

A word should be added regarding the fact that during the Civil Wars of Rome we read many references to the use of standing throwing-machines in ships; this should be ascribed to the circumstance there are many writers of the day and not be held to show machines were then first in ships. It was similar in the day of the Great Ocean Voyages about 1500; then we hear much of what is called navigation, direction of ships on the high seas; but this is not due to the science and art being then created as by the waving of a wand but to the fact that then seamen first wrote their own stories. We first hear much of standing throwing-machines in ships during the Civil Wars of Rome at the beginning of the Christian Era and of navigating ships on the high seas when the Great Ocean Voyages began about 1500; but we hear of them before and must conclude they were in use at the earlier date.

CICERO'S EXPERIENCES AT SEA.

Cicero was killed 43 B C. Like most prominent public men he held command at sea. His letters are published and one illustrates the method of provisioning fleets for he says he must soon surrender his fleet because of high prices demanded for food in the foreign port where he is.[5] In such

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[3] Comm Bell 1908; Gallic War 4, 20; Civil War, 1, 25, 34; 3, 2. Cæsar writes, "When Cæsar came to Brundusium he made a speech to his soldiers xx. They cried out with one voice, 'He might give what orders he pleased they would cheerfully obey them.' He accordingly set sail the 4th day of January with 7 legions onboard;" Alexandrine War, 8. In African War ch 1 is stated he sailed Dec 25 47 B C from Sicily for Africa.

[4] Plutarch's Cæsar Langhorne v 4 p 255.

[5] Shuckburgh ed v 4 p 306.

circumstances he was powerless and must have been without round-ships carrying stores. The historian Polybius also once commanded a fleet and took it into the Atlantic; he writes of this,[6] "I confronted the dangers and fatigues of my travels in Lybia Gaul and Iberia as well as of the sea that washes the western coasts of those countries."

In one of his letters Cicero says he is writing on the deck of his ship when well out at sea and must have been fairly comfortable. He narrates also the circumstances of a voyage from Patras to Brindisi 300 miles in all. The vessel was a long-ship;[7] sailing from Patras Nov 22 she followed the coast stopping at intermediate places 6 times, remaining once 7 and on another occasion 6 days, and reached Brindisi in 22 days. No doubt she stopped over-night and at meal hours to allow passengers and crew to go onshore. The longest stretch at sea was from Corfu across the Strait of Otranto 80 miles traversed, "With a gentle south wind and clear sky" in 24 hours. The stays in port were waits for favorable weather.[8] The ship made good during the voyage only an average of 14 miles per day, when crossing the Strait she made less than 4 miles per hour.

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[6] Shuckburgh ed bk 3 59: the date is 175 B C.

[7] Though often becalmed and beset by foul wind round-ships made long voyages in shorter time than long-ships; but for short distances the latter using sails when possible and having considerable oar power were preferred though rates of passage in them must have been high. They often made passages with cargo and passengers carrying only part crew of rowers. The point where long-ships gave better service than round-ships was where there was a lee behind which they could proceed: here round-ships would be helpless.

[8] Letters Shuckburgh ed v 2 p 212; the 7 letters preceding one dated Brindisi Nov 26.

CHAPTER V.

Round-Ships, 500 B C to 500 A D.

Round-ships carried produce and accompanied war-fleets, carrying provisions stores water fighting men to be landed, and aboard them cooking was done for the fleet. They were perhaps more important in the life of ancient peoples than in ours, but though what we read of them suffices to show what they were like and how used, there is little said of them directly. Herodotus Thucydides and others tell of expeditions of military character saying round-ships were in the fleets but little more. Nowhere is it recorded for example what round-ships accompanying war-fleets did when long-ships were beached for the crew to land for a meal to stretch themselves or to sleep, whether they anchored in the harbor lay-to off it or proceeded with the breeze towards an appointed rendezvous. The 2 classes of ships differed so radically and proceeded at sea in ways so opposite that it may be assumed they did not remain close together.

When carrying freights round-ships were unaccompanied by long-ships and before the beginnings of our records they were thus employed. Of such voyaging cases have been mentioned, the stone brought for the statue of Gudea before 3000 B C [x] and the food-ships coming from afar alluded to in the Book of Proverbs being the most striking of these. Besides records of voyages, it is known that tin the precious metals pearls amber ivory silk cotton incenses and many live animals were carried at sea in early days. Herodotus writes regarding the temple of Belus in Babylon of an age much earlier than his own,[y] " It is on the great altar that the Chaldæans burn the frankincense which is offered to the amount of a thousand talents every year." This is a weight of 70000 pounds and it must have come from Arabia or further south.

ROUND-SHIPS WERE DEVELOPED FROM LONG-SHIPS.

Long-ships came before round ones, being originally trunks of trees hollowed out. Rafts also were used early and widely, but on rivers not on

x P 21 above: p 14 as to food-ships in Proverbs.

y Bk 1, 183: see Exodus 30, 20–26 for directions for mixing a large weight of incenses in the time of Moses; and above p 36 n 2 for waste of it by Alexander the Great.

the sea. These remain the same as always while built-up craft have developed into the modern ship the most elaborate and wonderful creation in the world. The first long-ships were tree-trunks hollowed out by cutting-tools and fire; these as knowledge advanced and better cutting-tools were acquired came gradually to be built-up of separate parts. From built-up long-ships advance was made to round-ships when it was realized that by making vessels deeper and wider more weight could be carried. Thus were developed bluff weight-carriers driven by sails with auxiliary and inferior oar-power. Both sails and oars were used probably before the advent of round-ships, and of the two it seems a use of sails as being the more obvious may have preceded that of oars. Oars have been used in three ways not counting pushing with them in shallow water, rowing paddling and sculling. Each was developed in waters appropriate; paddling in broken water, rapids in rivers and breaking surf, rowing and sculling in smooth water. The dates of the beginnings of these are deep in pre-historic ages: we may almost say they are as far back of the year 2750 B C when Sahure sent ships to Phenicia to procure ship-timber [9] as of our own day.

EARLY ROUND-SHIPS HAD ONE MAST AND ONE SAIL ON THIS.

The ships of Sahure and those sent by Hatshepsut to Punt in 1500 B C [1] were round-ships with one mast and one sail and many vessels are still rigged in this way in the Far East and elsewhere,[2] are so shown on the Bayeux Tapestries of the 11th century and on maps coins and other contemporary illustrations until about 1400.[3] This is a generalization with many exceptions. We need whatever aids to memory are possible and only by such plea can this be justified. Long-ships had certainly more elaborate masting at early date; Admiral Serre than whom there is no better authority respecting ancient ships reconstructs the Argo, of about 1250 B C, with a triangular jib like a modern one and two sails on her

[9] Above p 27.

[1] Above p 28.

[2] Laing writing in 1833 says, "The large open vessels which at present carry dried fish from the Lofoden Islands to Bergen although open for the sake of stowage are of a size to carry masts 40 feet long which are struck by the crew when not under sail, there being no standing rigging and only one large square sail;" Heimskringla v 1 p 137. The voyage is 600 miles of open sea.

[3] Jal Arch Nav v 1 pp 445, 136; v 2 pp 367–371; Lindsay Hist Merch Shipping; Ships and Sailors Cotterill and Little; The Ship Its Origin and Progress Steinitz; etc.

single mast.[4] Athenian trieres 3-oar fighting-ships had 3 masts with at least two sails on each about 400 B C:[5] thus round-ships had before them for centuries example of what has been the principal improvement in masting; use of more than one mast and several sails on each.

The single sail of round-ships was square deep big-bellied and flowing; it seems impossible the ships could have sailed close to the wind. They had a yard at the head of the sail, but I can recall no ships but those of Hatshepsut with one at its foot also.[6] When the Great Ocean Voyages began about 1400 demands were for the first time made for ships of the West to cross wide stretches of water carrying heavy cargoes store of food and water and numerous passengers in conditions at least endurable and as a result they became deeper and wider and tempted by the desire to house crew and passengers in comfort higher out of water. The bow and stern, the last in greater degree, grew to an amazing height and though the danger and evils entailed were obvious this endured long; high sterns longer than high bows for in the last only the crew lived. These vessels had more than one mast and on each more than one sail with yard at head and foot; all had yards at head and foot but the lowest sail, the *course* it is called.[7]

PULLEYS AND CAPSTANS.

Pulleys and capstans must have been used by round-ships as soon as large enough to carry considerable cargo, for pulleys not what sailors call *dead-eyes* dumb pulleys without sheaves but with revolving sheaves, are necessary to handle sails as soon as these with their mast grow too large and heavy for a man to lift the mast with the sail on it from the step of the mast and lay them down. Sails of reasonable size cannot be used without ropes and pulleys, sheets and tacks clew-lines bowlines etc. Capstans also are very old, for some of the yards in Hatshepsut's ships of 4000 years ago appear at the mast-head and others down; and in later day capstans are mentioned as used to haul ships over land.[8] Ancient authors deemed tacks and sheets halliards etc of

[4] Mar de Guerre v 2 pl 4: there are only 2 sources possible respecting the Argo: Homer and the Argonautics of Apollonius Rhodius. The Argo was 400 years before Homer and 1000 before Apollonius.

[5] Above p 92.

[6] Above p 28.

[7] Below p 313, also immediately below in citation from Seneca.

[8] Above p 143.

fabulous age; Seneca who wrote about 50 A D says of Tiphys[9] helmsman of the Argo 1250 B C, "Tiphys made bold to spread his canvas on the vast deep and to write new laws for the winds: now to spread the full-bellied sail now to haul forward the sheet and catch cross breezes now to set the yard in safety midway of the mast now to bind them at the top, when the too eager sailor prays for wind and aloft the ruddy topsails flutter." Here are sailing large and close-hauled reefing furling sail with the yard aloft and the use of sails above the lowest;[1] yet most illustrations of ancient and mediæval ships show one mast and one sail on it.

NAMES BY WHICH TYPES HAVE BEEN CALLED.

As in our day the names by which types were called are legion and as now also these mean little. The name round-ship standing for the sea-keeping cargo-carrier is very old. The type is pre-historic and we find the name Herodotus,[2] "The Phæacians were the first of the Greeks who performed long voyages. x. x. x. The vessel which they used in their voyages was not the *round-built merchant-ship* but the long *penteconter*." He was writing of early Greek exploration and settlement in the western Mediterranean 500 years before his own time; the Greeks were cruising in search of places to land and settle and their knowledge being inexact or as we would say now, because their charts were poor, were obliged to land to enquire the way they had best go. The ships being penteconters—low straight undecked vessels with 25 oars on each side all in one horizontal line—it was easy to do this. They were near the land knew little about it and wanted to communicate with it often; thus sailing or round-ships were not convenient and safe. The Greeks then used the name round-ship about 1000 B C. We have it used in the Bible in the same day for the words in the Book of Proverbs,[3] "She is like the *merchants'-ships* she bringeth her food from afar" mean round-ships. The use of this term nearest our own day that I can remember for at present one never sees it is by Fournier who wrote in his Hydrographie printed 1667 of *vassieaux ronds;* we have it thus during about 3000 years. The type itself is much older and exists still indeed for modern sailing ships are round-ships.

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[9] Medea pp 259–60 v 1 Miller trans 1917.

[1] In the trans parallel Latin and English versions are given: thus early Latin sea-terms are shown.

[2] P 13 above.

[3] P 14 above.

There is a type-name which was used in the Mediterranean until the late Middle Age to mean a large sea-going freight-carrier; *chelande galandre zalandre.*[5] The writer of the Periplus of the Erythræan Sea who lived about 60 A D says ships which go from India to Chryse and the Ganges, "Are called *colandia* and are very large."[6] Etymologists believe colandia is derived from the Sanskrit *Kolantarapota* which means, "Ships for going to foreign shores."[7] This would indicate that the word which came to be chelande was derived from that of craft plying south of Asia before 1000 B C; before the date of the ships referred to in the Book of Proverbs and by Herodotus. Large cargo-ships were then used in the East earlier than the West and were to be found 3000 and more years ago from the Red Sea east to the Peninsula of Malacca. Because in like surroundings men become alike, the skippers mates and foremast hands of the 100 generations of seamen who made their homes in these craft were like the sailors of Smollett Marryat and Cooper. The word chelande gave place to *nau nef navire* in the Mediterranean and to *schiff ship* in the North.

ROUND-SHIPS DURING THE PERSIAN AND PELOPONNESIAN WARS; 500 TO 400 B C.

Herodotus says round-ships were used in the Persian expeditions against Greece and Thucydides recounts their services during the Peloponnesian War. The last writes into a speech of Nicias the commander of the Athenian expedition sent to conquer Sicily,[8] "Corn we must convey from home in ships-of-burden both wheat and parched barley and bread-makers impressed under pay from the bakers' shops according to their size, in order that if we be anywhere detained or weather-bound the armament may have supplies for great as it is it will not be in the power of every city to receive it." A little further on Thucydides says[9] while enumerating the ships assembled at Corcyra ready to cross the mouth of the Adriatic, "Besides these there were 30 corn-ships as transports laden with necessaries having onboard the bread-makers, also 100 barges which had been impressed and sailed with the corn-ships. There were too many

[5] Jal Arch Nav word *Chelande*: see also p 378 n 7 below as to chelandes.

[6] Periplus Schoff trans p 46. Chryse is the Peninsula of Malacca. See below p 207 as to the Periplus.

[7] P 246 work cited note next preceding.

[8] Bk 6, 19–26; above p 143: Nicias' speech is p 135 above.

[9] Bk 6, 42.

other barges and corn-ships which accompanied the armament voluntarily for trading purposes." Round-ships carried provisions and supplies and onboard them bread was baked and cooking done; it was not until the Middle Age when long-ships had grown large and oarsmen were slaves chained to their seats that cooking was done onboard. What Thucydides says of cities not having power to receive the men brings up the custom of their landing to buy food with sitos-money.[1]

ROUND-SHIPS IN BATTLE.

Round-ships were put in battles, put forward of the long-ships to break the charge of the enemy. The Roman Scipio disposed his heavy round-ships in this way in 200 B C, and this continued to form part of the plans of admirals until the Middle Ages were past.[2] The rule of putting heavy forces forward to make first contact has been reversed by commanders on both land and sea.

WHERE ROUND-SHIPS ANCHORED AND HOW THEY COMMUNICATED WITH SHORE.

Round-ships were too heavy and drew too much to be beached and let men land by jumping in the water. The ship of 10000 talents burden that went in 415 B C to Syracuse in Nicias' fleet has been alluded to and her weight or displacement-tonnage estimated at 900 to 1000 tons [3] and there is every reason to believe round-ships too large to do otherwise than anchor off from the land. The passage in Xenophon describing the good order in which things were stored in a large round-ship has been given in part [4] and there is a passage in the Comedies of Plautus a Roman author of 200 B C regarding the same kind of ship: a young man goes to Rhodes from Athens and upon return our author makes him say, "The merchandize which I had brought I sold xxxx; I made great profits." He bought a girl and brought her to Athens in the ship; "For the present," he says, "I've left her and a servant in the harbor onboard the ship." His father sees the girl, "Down onboard the ship as he stood near the prow and chatted with her." The young man enquires of the sailors

[1] Above pp 134–5 as to money value of sitos paid crews to buy food.

[2] Jal Arch Nav v 2 pp 269–77 regarding use of round-ships in fleets of long-ships: he gives words of authors of different dates, ending with those of Captain-of-Galleys Pantero Pantera in Armata Navale Rome 1614: above p 170 for arrangement of round-ships in battle by Scipio in 200 B C.

[3] Above p 145.

[4] Above p 67.

onboard, "Why didn't you stow her away that my father mightn't perceive her;" and the men reply, "Because we were busily employed about our business; we were engaged in packing up and arranging the cargo. While these things were being done your father was brought alongside in a small boat and not an individual beheld the man until he was onboard the ship." The father tells, "This morning at daybreak I went away hence down to the harbor. After I had transacted there what I wanted suddenly I espied the ship from Rhodes in which my son arrived here yesterday. xxxxxx I went aboard a boat and put off to the ship and there I beheld a woman of surpassing beauty." [5]

This is all as it might be today. Homer makes pictures of how long-ships managed and here we have the same as to round-ships. The boat in which the father put off and how did the son go ashore from the ship? Of course the last may have called a shore-boat alongside but we know that ships carried boats sometimes hoisted though perhaps towed more often than now. Here is the story of Pompey's escape after defeat at Pharsalia: he was seen from, "A round-ship just ready to sail;" her skipper, "Ordered the seamen to let down the ship's boat and held out his hand to Pompey to invite him onboard." [6] The ship in which St Paul was wrecked carried her boat hoisted: in the Acts we read, "As the shipmen were about to flee out of the ship when they had let down the boat into the sea xx." [7] Long-ships were provided with small boats which as they would have seriously lessened speed cannot have been towed but were small and could be got onboard without hoisting davits. At the Battle of Sybota 432 B C the Corinthians, "Put some men onboard a skiff and sent them xxxxxx to the Athenians;" [8] that is to the enemy. In Xenophon we read an admiral visits his ships previous to battle in a small boat: he orders, "His crews to get onboard their vessels. He then rowed alongside each ship in turn and addressed the men at some length in terms of encouragement and cheery admonition." [9]

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[5] Pp 138, 145 v 2, Com Plautus, play called Mercator, Riley trans in Bohn. The story is fiction; see just below for Pompey's boarding a round-ship to escape after Pharsalia and p 15 above for ways of long-ships in harbor.

[6] Pompey Plut Langhorne trans v 4 p 121; see p 67 same v for a similar case.

[7] Ch 27, 30.

[8] Thuc Dale trans v 1, 53: for similar thing see Cæsar's Com Civ War 4, 20; and Alexandrine War, 5 and 14; in former Cæsar tells his men, "To embark would require much time and be attended with great danger especially where it must be managed by small boats."

[9] Above p 142.

EARLY LONG VOYAGES.

Voyages along the south shore of Asia around Africa and north and south from the Pillars of Hercules in the Atlantic, by Phenician and Carthaginian seamen by Scylax and Nearchus Hanno and Himilco have been noticed.[1] We have also the voyages of Eudoxus of Cyzicus a Greek merchant and seaman who has a place with Doria and Vivaldi who passed out at Gibraltar in 1291 to go to India and with Dias and Magellan. The account of Eudoxus' voyages is from Strabo a reliable author who lived 50 years after him who says he took the account from Posidonius a contemporary of our navigator. There are parts of Strabo's narrative which are fables but we must expect these in ancient works for the human imagination was more alive in early days than now. Eudoxus being in Alexandria about 120 B C heard that a survivor had been found in a ship driven across from India. This man offered to pilot a ship to India and Eudoxus and others made the voyage and brought back great treasure but were robbed of it by the Emperor. Upon the death of the latter Eudoxus made another voyage to India and returning with treasure was robbed by the Emperor's successor, his wife Cleopatra. In returning from the second voyage in about 113 B C [2] he, " Was carried by the winds above Ethiopia "; that is he was blown south of the mouth of the Red Sea where ships were many in the day. Here he was shown, " The end of a prow with a horse carved on it which he was told formed a part of a wreck of a vessel coming from the west. He took it with him and proceeded on his homeward course." On reaching Alexandria then a principal port of the Mediterranean world, " He carried this prow to the market place and exhibited it to the pilots who recognized it as being come from Gades, the merchants of that place employing large vessels but the lesser traders small ships which they styled *horses* from the figure of that animal borne on the prow and in which they go out fishing around Maurusia as far as the Lixus.[3] Some of the pilots professed to recognize it as the prow of a vessel which had sailed beyond that river Lixus but had never returned. From this Eudoxus drew the conclusion it was possible to circumnavigate Libya."

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1 These are alluded to p 37 above.

2 The quotes are in Strabo Bohn in 3 vs v 1 pp 148–52: see Bunbury Anc Geog v 2 pp 74–79. Strabo died about 20 A D.

3 Maurusia was in the west of north Africa. The mouth of the Lixus is 80 miles south of Cadiz, 60 south of Gibraltar. Maurusia extended to 250 miles south of Cadiz.

Having been robbed by the Egyptian sovereigns Eudoxus struck out on his own account to reach India by rounding Africa. This was not to be attempted again until 1291 when Doria and Vivaldi attempted it and lost their lives; [4] it was accomplished 200 years later again by the Portuguese at the end of voyages extending over many years, the effort being promoted and no doubt its expenses paid by Prince Henry; the Navigator he is usually called.[5] Eudoxus procured ships at Cadiz and elsewhere placed, " Onboard singing girls and artisans of various kinds and launching into the open sea was carried towards India by steady westerly winds. However they who accompanied him becoming wearied with the voyage steered their course toward land; but much against his will." The ships went aground and were lost but Eudoxus saved enough to build another ship and, " Continuing his voyage came amongst a people who spoke the same language as that of some words which he had on a former occasion committed to writing. He further discovered that they were men of the same stock as those other Ethiopians.[6] xx However he abandoned his voyage to India and returned home."

This indomitable man made another attempt to go to India by way of the Pillars but of this we have not the details. At least one ship he took at Cadiz was a round-ship: long-ships were handy near the land but in a voyage around Africa life could be supported only in round-ships; unless indeed as told by Herodotus of early circum-navigation of Africa voyagers landed and planted corn and waited until it was ready to reap. The creditability of Strabo's account of Eudoxus is increased by an account of Diodorus the Sicilian who lived 30 years after him of a voyage of similar character. This author wrote,[7] " Now we propose to say something of a certain island lying in the southern ocean and of the wonders there giving

[4] Below p 304.

[5] There is ground to believe the Portuguese were not in the 100 years their ships were advancing south along the west coast of Africa endeavoring to reach India by sea but actuated by desire to trade, being thus gradually drawn south and finally to double the Cape.

[6] That is the people found spoke he believed the language he had before encountered on the east coast south of Ethiopia. Many believed there was a water route around Africa before Dias found it: Aristotle wrote about 325 B C, " The Indian Ocean appears gradually to communicate with the Atlantic"; see Vincent Com and Nav of Anc v 2 p 231 note 409. Herodotus 100 years before Aristotle's day narrates Phenician ships rounded the Cape west-bound 200 years before his time and those of Carthage east-bound a little later.

[7] Booth trans 2 vs 1814, v 2 4; see same work 5, 2 for mention of islands *west* of Africa.

first an exact account by what means it came to be discovered. x xxxxx One Iambulus from his youth studious and learned xx xxx being tossed for 4 months together having passed over a vast ocean in a ship with 6 months' provisions; [8] xx xxx being directed by an oracle": in this island, "The days and nights are always of an equal length neither is there any shadow at noon-day because the sun is directly in the zenith overhead. x x x The Bear Star and many others visible to us are never seen there."

Diodorus does not give the island a name except to call it Fortunate Island but if an island it must have been Ceylon. The account has little interest except to confirm our impression that the Greeks and Romans went to India by sea in these days. Megasthenes a follower of Alexander the Great went to Ceylon about 300 B C, and Ceylon is mentioned by Eratosthenes who lived 50 years after Megasthenes.[9] Eratosthenes probably heard of Ceylon and where it was, Taprobane it was called, not from accounts brought to Alexandria of the wanderings of Megasthenes from the mouth of the Indus south through the length of India but from logs of seamen who had sailed thither. Diodorus describes Fortunate Islands in the furthest west in the sea west of Africa as follows, "Since we have gone through the islands lying eastward on this side x x x we shall now launch into the main ocean to those that lie beyond, for over against Libya lies a very great island in the vast ocean of many days sail from Libya westward xxxxx." These were known long before the day of Diodorus; Bunbury shows that Madeira is referred to in 250 B C and that the island had been visited earlier by Carthaginian seamen.[1] Thus the ancients called islands in the Far East Fortunate Islands as well as those in the Far West.

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[8] Few tales of any age can be accepted entirely: but that such words as these should be written proves ships were provisioned for long periods; were sea-keeping like sailing-ships of our day.

[9] Below p 328 for what Strabo says of Greek and Latin ships in the East in about his own day and 250 years before.

[1] Bunbury Anc Geog v 1 p 605: also p 38 above. Plutarch in his Sertorius tells us this Roman general when in Spain north of Cadiz in 81 B C, "Found some mariners lately arrived from the Atlantic islands. These are 2 in number separated only by a narrow channel and are at a distance of 10000 furlongs from the African coast. They are called the Fortunate Islands." This must mean Madeira where there are 2 principal islands, Madeira and Porto Santo. They are 600 miles S W by W from Cadiz. It is uncertain what is meant by *furlongs*. If the islands were not stated to be 2 in number we might suppose it meant the Azores: these are more numerous and W by N 1000 miles from Cadiz. The matter of interest is that for 200 or 300 years before Sertorius was in Spain ships had been going and returning several hundred miles in the Atlantic in latitude 35°: the ships' crews were Phenicians Carthaginians or of Spain, not Greeks or Romans.

THE VOYAGE OF ST PAUL.

We come next to the principal sea-voyage of St Paul for he made many.[2] The principal voyage was from Cæsarea to Rome in 2 different ships one of which went on the rocks at Malta.[3] The longest continuous run was 600 miles and made in 14 days, during part of which the ship was forced to run; at this time, "They used helps under-girding the ship xxx x and so were driven. And when neither sun nor stars in many days appeared and no small tempest lay on us all hope that we should be saved was then taken away. xxxxx The shipmen sounded and found it 20 fathoms and when they had gone a little further they sounded again and found it 15 fathoms." The second ship carried 276 persons and a cargo of wheat.[4]

LUCIAN'S VOYAGE.

The voyage of a round-ship is described by Lucian an author of 200 A D.[5] The ship was 180 by 50 by 36 feet from deck to keel and was considered very large as she is said to have brought, "Corn enough to supply the inhabitants of Attica for a whole year." The play is in the form of a party of young men who visit the ship on pleasure bent. One of the most interesting points is the statement, "One little old man governs all this with a small pole which he guides the rudder by" for it indicates a hinged rudder hung as ours are. Jal who had had experience at sea and was a student of ancient and mediæval ships shows this vessel was of the size of an 86-gun ship of the French navy of 1830 and adds, "Can any-one be disposed to accuse the constructors of antiquity with ignorance."[6] There are many cases of very large ships of mediæval days cited in Jal's work.

The voyage of Lucian's grain-ship can be reconstructed: she was bound from the Nile to Rome was driven by foul wind to the coast of Syria and was later more than once driven from her course. She made

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[2] Acts 2, 5; 13, 4–15; 20, 6, 15; 21, 1–7: some can be constructed.

[3] The story is in chaps 27 and 28 The Acts and all known of it is there: see below p 222 and Smith's Voy St Paul and Ramsay's St Paul.

[4] Some ships were larger: Josephus a writer of the same day was wrecked in a ship carrying 600; see Josephus Whinstone trans p 656 ed 1737.

[5] Works Lucian of Samosata 2 vs Francklin trans v 2 pp 412–15; a play called The Wishes. See p 216 below for 2 other voyages in this date.

[6] Arch Navale v 2 p 150. A statement p 263 this v shows Jal believed round-ships always struck out directly across the sea for their destination: p 437 is a statement showing he believed that ships of the day of this one used steering oars and not hinged rudders but it seems impossible ships so large and high could have steered by oars.

good in all from the Nile to Athens for which only general courses are given about 1100 miles in 70 days, and no doubt actually sailed much further; she was hove-to at times. During these 70 days she was not in harbor; and we read that in crossing the Ægean Sea the wind, " Blew full against them." The north wind which prevails there in summer would be scant for her course. Of another ship we read in Lucian that when driving in a gale she towed a rope, " To somewhat break the force of the waves " that her passengers had private cabins and that she was supplied with cork life-preservers.[7] The following regarding passengers is in Lucian, " If there had been a captain supervising and directing in the first place he would have known the difference between good and bad passengers and in the second he would have given them their deserts; the better would have had the better accommodation above by his side and the worse gone below; with some of the better he would have shared his meals and his counsels." [8]

WHAT PLINY WROTE OF THE SIZE OF MASTS.

Both translators of Lucian write of " cabins " and of, " A mast and sail-yard "; so presumably though so large the ship had a single mast and sail. In regard to size of ships it may be added that Pliny says the mast of a ship that brought an obelisk from Egypt to Ostia the port of Rome about 40 A D was a single stick made from a fir-tree it took 4 men to span; [9] this would equal the mast of the 86-gun ship to which Jal likens Lucian's grain-ship. The story has every appearance of likelihood for Pliny says in another place [1] one obelisk brought to Rome was 85¾ feet high and another 9 feet less.

WESTERN MERCHANTS GO TO THE FAR EAST.

When the Ptolemys ruled Egypt Alexandria being their capital 332 to 31 B C and the Romans after 30 B C that city was the greatest sea-port in the western world and many ships probably owned and manned by Greeks and Romans of Alexandria descended the Red Sea and went on to the Far East. Strabo says the number of these in his day about 20 A D was very great and that the movement had begun 2 or 3 centuries earlier

[7] Lucian trans Fowler and Fowler v 3 pp 46–7; a play called Toxaris. The points last mentioned are in Francklin's trans v 2 p 105 play Toxaris, but the translation is not intelligible.

[8] P 103 v 3 Fowler and Fowler trans a play called Zeus Tragœdus: the passage is p 184 v 2 Francklin trans.

[9] Bohn ed 6 vs p 419 v 3; Pliny's date is 70 A D. See also below p 223 as to masts.

[1] P 331 v 6 same ed.

when the Greeks first ruled Egypt.[2] The voyages of Eudoxus and Iambulus recounted just above show that westerners were going to the East at even earlier date, but whether western ship-builders built the ships used and western seamen manned them there is no means of knowing.

THE NATIVE SHIPPING IN THE EAST.

There was from very early date a native shipping in the East, certainly Chinese and Arabian and probably Persian and Indian as well. As early as 300 B C there was established in India a board for regulating shipping[3] and of date shortly later an Indian work records, "In these Chola ports there were lighthouses built of brick and mortar which exhibited blazing lights at night to guide ships to port."[4] There are many proofs of early shipping in the East. In pictures found in caves are representations of ships brought by the conqueror Vijaya to Ceylon about 550 B C, the ships being beached and having oars as would be the case with Greek long-ships of the same date;[5] some are shown with horses and elephants onboard indicating large animals were carried. In European waters also these were carried, Pyrrhus King of Epeiros brought elephants across the Adriatic in 281 B C and the early Greeks named ships for carrying elephants *elephantegoi*. About 800 A D Haroun-al-Raschid sent an elephant by sea to Charlemagne and in 1505 the Portuguese sent one from Ceylon around the Cape of Good Hope to Portugal; the beast coming finally to Pope Leo X to which circumstance we probably owe its having been recorded.[6] The pictures in Herringham's Ajanta Frescoes

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[2] Below p 328.

[3] Mookerji Hist Indian Shipping p 104; p 26 says ships of India had private cabins at early date; p 29 that some could carry 800 persons. If our record is complete the first board to regulate western shipping was 1800 years later than the one in India; see below p 295.

[4] P 137 work last cited; Chola is in S E India. P 163 says Indian ships went to China by beginning of Christian Era but Chinese ships did not come so far as the Malay Peninsula before about 350 A D nor proceed thence to India Persia and Arabia until a century later.

[5] Ajanta Frescoes Herringham 1915 pl 17 and 42: see also above p 39, Darius "Used" the sea-commerce near the Indus about 600 B C.

[6] Hist Portugal 1495–1521 Osorio Written 1571 in Latin and trans into English p 143 v 2; Albuquerque Stevens p 35. There is little regarding the Empire of the Portuguese in the East not in these 2 works: it was of and upon the sea; its viceroys were seamen and disputed whether or no a dominion could be held by ships without posts on shore. As to elephants see Armandi Hist Mil des Elephants, and Heeren Hist Res Africa v 1 pp 253–4 note Eng trans. See p 566 n 1 below for Albuquerque's conclusion an empire resting on power of ships alone cannot last.

are very fine. That of the landing of Vijaya is represented in Mookerji as well where it is added native writings show some of the ships had 700 persons onboard.[7]

THE PERIPLUS OF THE ERYTHRÆAN SEA: THE HIPPALUS OR SOUTH-WEST MONSOON.

Of the person who wrote the Periplus it is known only that he was a Greek and wrote—his book would now be called a Sailing Directions—about 60 A D. By Erythræan Sea he means the Red Sea and the ocean beyond as far as the Strait of Malacca. He wrote regarding the voyage from the mouth of the Red Sea to the peninsula of India, " Hippalus was the pilot who by observing the location of the ports and the conditions of the sea first discovered how to lay his course straight across the ocean. For at the time when with us the etesian winds are blowing on the shores of India the wind sets in from the ocean and this south-west wind is called Hippalus from the name of him who first discovered the passage across." [8] The Periplus goes on to explain how the voyage was made before by coasting around and how ships steered across close by the wind. Bunbury gives translation of the pilot's words which cannot but carry conviction their writer the unknown author of the Periplus had seen ships in a sea-way struggling to windward.[9]

Our author made a mistake; Hippalus could not have been the first to point out how to cross the Indian Ocean; some 1500 miles, it was not a great undertaking. Eudoxus as we have seen crossed twice 150 years earlier and Pliny whose work was written the same time as the Periplus, who also says the S W monsoon was called Hippalus, says of Ceylon or Taprobane, " During the reign of the Emperor Claudius (41–54 A D) an embassy came from this distant land to Rome. xxxxxx Annius Plocamus xxxxxx a freedman xxxxxx while sailing around Arabia was carried away by a gale. xxxxxxx In 15 days xxxxxx he had come to a port of Tapro-

[7] The pict is p 44, the statement about number onboard p 28: see also Yule Cathay 2 vs p clxxvi note v 1. For other repres early Indian ships see Elliot Coins Anc India, in Internat Numismata Orientalia: some coins are shown p 51 Mookerji where is also a reference to spoon-oars: see p 28 above for spoon-oars in Egypt in about 2000 B C.

[8] Perip Eryth Sea Schoff p 45. The Periplus will be found treated in detail in Vincent Com and Nav of Anc. The etesian wind is the north wind that blows in the eastern Medit during the summer; the word is Greek for seasonal or periodic as monsoon is Malay or Hindu for the same. The S W monsoon blows during the season of the etesian wind.

[9] Hist Anc Geog v 2 p 470; also pp 417–23.

bane."[1] This freedman remained in Ceylon 6 months and returned to Rome with an embassy. It is a fair inference from Pliny, the Periplus does not mention this freedman, that the latter's voyage was before Hippalus pointed out the way, and is nowhere stated that Hippalus made the voyage himself. The embassy came from Ceylon to Rome and 100 years later in the reign of M. Aurelius 160–180 A D a Roman embassy went to China by sea.[2]

The author of the Periplus did not go further than India as his work shows, but wrote of China, having heard of it no doubt from mariners who had been there or perhaps only as far as Java hearing there of the more distant land. " A great inland city called *Thinæ,*" he writes, " From which raw silk and silk yarn are brought on foot through Bactria to Barygaza and are also exported to Damarica by way of the river Ganges. But the land of *This* is not easy of access; few men come from there and seldom."[3] The land of *This* is China; one of the many names by which it has been called. From the Periplus it is not clear the author's knowledge of This came to him by sea but authors of days shortly following derived this by ships.[4] As mentioned just above Roman ambassadors went to China by sea about 150 A D, and in the same date the land is alluded to by 2 authors in ways showing what they knew had come by ship. A modern author writes,[5] " In the time of Ptolemy (150 A D) another source of information was opened; we speak of maritime communication. We have the proof of this in the name *Sinæ* given by him to the people he places on the shores furthest to the east. The origin of Sinæ is the Arab word *Sin;* for Arab navigators Sin was the country of *Tsin,* China. Ptolemy had then a double notion of this country; one coming by land if we may so speak and which he designated by the name *Serica* or the country which produces silk, the

[1] Pliny Bohn in 6 vs v 2 p 52: see p 62 same v as to Hippalus: The ship ran 1800 miles in 15 days; 120 miles a day: the story as we have it proves the voyage had been made before.

[2] Mem Acad Inscriptions v 32 p 355 1768 article by Deguignes, cited by Yule Cathay v 1 p lxii. It is stated in the Chinese work from which Deguignes translates that the Romans went by sea because the Parthians whose territory intervened would not allow them to pass by land.

[3] Periplus Schoff p 48; Bunbury Anc Geog v 2 p 443. Thus in the day of the Periplus silk came overland to the Ganges and thence by ship for Damarica was in the south of India.

[4] Above p 24 it is indicated the prophet Isaiah of about 750 B C knew of China and that his knowledge came by sea.

[5] Pariset Hist Soie p 108 v 1. This author shows silk cotton ivory incense tin amber and other foreign products have been used in Europe since immemorial times: if their history could be written a long stride in the history of ships would be made.

other coming by sea and which he designated by its true name Sin or the country of *Thsin*."[6] A Greek named Pausanias wrote a work on geography he calls an Itinerary of Greece about the day of Ptolemy and confirms what Pariset says; he gives a correct description of the origin of silk, before his day supposed by people of the West to be combed from trees, and the description it is plain came to him by sea; "The island of Seria," he says,[7] "Is known to be situated in a recess of the Erythræan Sea. xxxxxx The silk collected in the country of the Seres is not the product of a plant. There is in this country a worm xx."

Before leaving the matter of the route to India from the Red Sea it should be noted that voyagers native in that region knew the monsoons and sailed by them many centuries before the day of the Periplus. Few phenomena of nature were noticed before the monsoons[8] and skippers would learn to go straighter across by cutting gradually from the coasting voyage more and more as they found the winds blew in the open sea as well as on the coasts. There can be no doubt ships in the waters of Asia; Phenician Arabian Persian Indian Javanese Chinese; used the monsoons in remote antiquity. When the author of the Periplus Pliny and others witnessed or heard of them they were discovered to the West.

THE SHIPS MAKING LONG VOYAGES WERE ROUND-SHIPS.

The ships making long voyages were round-ships capable of keeping the sea almost indefinitely. It is plain from the Periplus that the ships the author was in were large and anchored off from the land as trading-ships now anchor. Such vessels only could make the long passages common in the East in early days but unpracticed by people in the Mediterranean basin. Along the south and east coasts of Asia the monsoon winds blow and ships were sure of 125 to 150 miles per day. It cannot be these winds were unknown to seamen on the coasts where they prevail and western voyagers who first realized their character do not say they had not been used until their own day. As indication how quickly men recognize and utilize natural forces these words of Pliny may be quoted,[9] "When winds which are contiguous succeed each other they go from left

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[6] See Yule Cathay 2 vs p xxxiii v 1 as to double name given China.

[7] Frazer trans Pausanias p 324 v 1 (bk 6, 26). Part of the trans I give is from Pariset Hist Soie p 205 v 1. See also above p 36.

[8] Above p 51 as to the remote age in which phenomena of nature were observed.

[9] Bohn in 6 vs v 1 p 78: many of the present day are not aware of this.

to right in the direction of the sun"; or Marco Polo's description of monsoons the best and simplest ever written perhaps; "It takes them a whole year for a voyage," he says,[1] "Going in winter and returning in summer. For in that sea there are but 2 winds that blow the one that carries them outward and the other that brings them home and the one of these winds blows all the winter and the other all the summer." Polo was on his way by ship from Chin Cheu, Zayton he calls this, to the Persian Gulf and at the moment in Sumatra and speaking of the voyage from China there.

POSITION-FINDING AT SEA IN THE EAST.

Long voyages were made in the East much earlier than in Europe. The Northmen came to Syria during the Crusades and crossed the Atlantic earlier, ships of several nations were in the islands west of Europe and Africa at the beginning of historical records, those of Phenicia Egypt and Carthage went all over the Mediterranean and down the Red Sea and east coast of Africa centuries before the Christian Era; but not until the era of the Great Ocean Voyages did a western ship make a run such as from China to the Red Sea. The only great deep-sea voyage told of westerners, if indeed we call the people of Tyre by that name, is that of the ships of Hiram of Tyre with servants of King Solomon onboard to India in 1000 B C.[2] But no-one can consider existing evidence and conclude otherwise than that ships of the East, of China Java and Sumatra India Persia and Arabia, made voyages along the south and east coasts of Asia and down the coast of Africa centuries before the Christian Era. Here the monsoons prevail, and it cannot be that traders eager for quick return on ventures did not go with one monsoon and return with the next. If driven beyond the region where these winds blow, or if they went as far as Australia or near-by islands, as many believe, they ran into the trade which used with the monsoons, would serve every purpose.

In making long voyages for many years seamen of the East may well have learned better ways than those of the West but could not have learned to determine longitude. There exists little as to their methods but Da Gama stated when he reached eastern seas in 1497 pilots there had better charts than his own and better instruments for measuring altitude:[3] the instruments were better because they held on the horizon and

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1 Cordier's Yule's Polo v 2 p 264.

2 Above p 35.

3 Below p 247 n 4.

were thus independent of gravity and the swing of the ship which so greatly affected the astrolabes and quadrants the Portuguese used; the charts because made, " Without that multiplication of bearings of points of the compasses usual on our charts " ; without the radiating lines drawn all over western charts.[4] A chart called *Mohit* has been re-produced in recent days from records of eastern ships. It is very accurate and like those of today,[5] and is said to show the state of eastern knowledge and cartography in 1550, which is the year of setting in order its data. The longitudes used in plotting the Mohit could have been determined only by ships' reckonings east and west; by dead-reckoning.

THE MIDDLE MAN.

There are accounts of other voyages before 500 A D, but before these may be placed what is known as to the number of merchants through whose hands goods passed in coming long distances. The middle man is very old indeed. Among the carvings showing the ships of Queen Hatshepsut going to Punt about 1500 B C [6] is an inscription as follows, " No-one trod the Myrrh-terraces which the people knew not; it was heard of from mouth to mouth by hearsay of the ancestors. xxxxxx The marvels brought thence under thy fathers the Kings of Lower Egypt who were of old as a return for many payments." [7] Written on a globe of the earth which was making by Martin Behaim when Columbus was first crossing the Atlantic and which is still in existence is a list of the 12 duties and profits spices paid before reaching the consumer in Europe: [8] the first is, " The people of the Island called Java Major buy them in the other islands where they are collected "; the 6th, " Those of Cairo buy them and carry them over the sea and further overland "; the 7th, " Those of Venice and others buy them." In the same place on the globe is written, " These are the words of Bartolomeo of Florence who came out of India in 1424 and told Pope Eugene IV at Venice what he had seen and experienced in 24 years." The route by which spices came must always have been in considerable

4 Below p 297 where the lines on charts are alluded to.

5 See First Voy Gama Hakl p 209 for picture of the Mohit and statement whence it has been drawn: also p 26 same work.

6 Above pp 28 and foll'g.

7 Breasted Anc Records Egypt v 2 par 287.

8 Ravenstein Behaim and His Globe p 89; Com and Nav of Anc Vincent v 2 p 577, note. See above p 194 as to spices.

part by sea; there are many proofs they came in very early days; Hatshepsut wrote in 1500 B C they had come "of old."

THE DISTANCES PASSENGERS OR CARGOES WENT WITHOUT CHANGING SHIPS.

These words of Hatshepsut and Bartolomeo of Florence of 1500 B C and 1492 A D are often taken as proving that ships did not go far in early times; that more than one ship was used in transporting long distances. Many voyages were of course short but not because of incapacity of ships to go further; Homer tells of a ship being at sea 18 days the Book of Proverbs of food-ships coming from afar the ships King Solomon sent to India about 1000 B C were gone 3 years and the grain-ship Lucian tells of was at sea 70 days. Where monsoons blow a ship would cover great distance in 50 days and there would be expense in trans-shipping a cargo. Bartolomeo told of the condition of the spice trade in the East, not of the ways of ships. He may have known that 200 years before Marco Polo came from China to the head of the Gulf of Persia in a Chinese ship and that this voyage was commonly made in his own day. Marco's ship sailed from Zayton probably in January 1292 and reached Sumatra April following; here she lay 5 months as the time for the S W monsoon was too near for west-bound ships to sail, and departing when the N E monsoon came crossed to Ceylon. Here was passed the season of the S W monsoon of 1293, the ship reaching the head of the Persian Gulf in March 26 months after sailing from China.

The run is in all 8000 miles which a ship could cover in 100 days in one monsoon, but the voyage was not for trade and manners of the day were leisurely. They had in the ship a young noblewoman of China who was coming to be married to a prince in Persia. The prince was old and died before the arrival of the ship and a son replaced him as bridegroom.[9] As to Chinese ships Polo says they are of fir; often have 50 or 60 private cabins, "Wherein the merchants abide greatly at their ease every man having one to himself"; have one rudder and 4 masts and 2 additional masts which they ship and unship at pleasure; "The larger of their ships have some 13 compartments or severances in the interior; xxxxxx in case mayhap the ship should spring a leak xxxxxx the mariners having ascertained where the damage is empty the cargo from that compartment into those adjoining xxxxxxx and then stop the leak and replace the lading." Ships he says have 200 to 300 mariners onboard and draw 20 feet of

[9] Cordier's Yule's Marco Polo v 1 p 23: below p 251.

water.[1] Such a ship could have been designed only for long voyages in the open sea; they feared the land and gave it a wide berth.[2]

LIFE IN SHIPS.

Life at sea was full of danger and rough experiences whether in round- or long-ships but particularly in the last if caught at sea in heavy weather when because these to render them easy to row were light of little draft and low between-decks where there was not room for all onboard the discomfort wet and exposure must have been very great.[3] The Roman poet Ovid was exiled to the banks of the Danube in 25 B C performing the journey in round-ships. At the Isthmus of Corinth as was usual to avoid going south-about around Greece he changed ships.[4] He writes to his wife in Rome, "Either the Adriatic Sea beheld me writing xx while I was shivering in the month of December or after I had passed on my route the Isthmus of the Two Seas and another ship was taken. xx Often did she ship a sea yet still with trembling hand did I compose my verses such as they are. xxx I write not as I once did amid my gardens; xxx I am tossed on the unruly deep and my very paper is dashed o'er by the unruly waves." [5] People were not always uncomfortable at sea however; Aristophanes 300 years earlier than Ovid wrote, "As I was reading the Andromeda to myself onboard the ship." [6] He could not have been very uncomfortable.

MAPS IN DAYS AFTER THE EARLIEST.[7]

Cicero whose date is 50 B C states a geographical fact and says it is, "On the authority of the map of Dicæarchus a respectable writer and one who has even received your approbation." [8] Dicæarchus lived about 250 years before Cicero and the passage implies maps were to be found in many

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1 This datum alone shows the ship was large and sea-keeping. The historian Polybius writing 1500 years before Marco Polo shows ships in the Mediterranean were as large as Marco's ship; he says bk 4, 40 "The greater part of the Sea of Azov is only from 7 to 5 fathoms deep and accordingly cannot any longer be passed by large ships without a pilot."

2 The quotations given are v 2 pp 249–51 (bk 3 ch 1), ed cited 2d note above.

3 Below p 499 for description of a mediæval galley at sea.

4 This place is of great interest. Ships were hauled overland 5 miles on a railway from one sea into the other: the ship-way called *diolkos;* see Thuc 3, 15; Strabo 8, 6, 4; Pomponius Mela trad Fradin 2, 3. In Roman days there were attempts to cut a canal here.

5 Ovid Bohn in 3 vs Tristia bk 1 el 2 p 253.

6 Frogs line 55 p 525 v 2 Bohn.

7 See above p 21 as to early maps.

8 Shuckburgh ed v 2 p 150: Bunbury Anc Geog v 1 p 617.

places; lying about probably. Many references of ancient authors to maps might be cited: Aristophanes in a play introduces 2 actors one being an unlearned person and the other a scientific student. They are in a school-room and the following dialogue occurs; the unlearned person speaking first:

> " What then is the use of this?
> To measure out the land.
> What belongs to an allotment?
> No; but the whole earth. See (pointing to a map);

here's a map of the whole earth. Do you see? This is Athens, and Eubœa here as you see is stretched out a long way."[9] What was used to measure on maps; a measured stick, pair of dividers? Whatever it was the words show men were familiar with measuring on a chart which is the same as saying they made charts to scale.

To show maps were common and numerous, and may well have been carried always by ships, further references will be given: Plutarch writes in his Nicias when telling of the Athenian fleet sent to Syracuse in 415 B C,[1] " The young men in their places of exercise and the old men in the shops and other places where they conversed drew plans of Sicily and exhibited the nature of its seas." At the time of the Persian invasions of Greece nearly 100 years earlier than Nicias a map showing lands and seas between Greece and Persia was exhibited to the King of Sparta.[2] Agrippa the admiral of Augustus and commander of the Roman fleet at Actium prepared a great wall map which was hung publicly in Rome.[3] Far away, in a place with which there was little interchange of plans and ideas, maps were drawn: about 265 A D in China a wall map of 84 pieces was made of silk which being found inconveniently large was reduced to 10 feet square. In this reduced size its scale was 30 miles to one inch;[4] a ship's day's-run on it would be 3 or 4 inches long. A Chinese map on large scale for use in ships and of about 1400 is mentioned above and European ship-charts of the same date.[5]

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[9] Clouds Hickie trans in Bohn p 126, 203–20. The allotment means of land to an individual; these gave rise to geometry and mensuration: Aristo's date is 450 B C.

[1] Langhorne trans v 3 p 266. Plutarch wrote about 35 A D. Nicias was commander of the exp referred to.

[2] Above p 22 for Herodotus' words about this.

[3] Bunbury Anc Geog v 2 pp 177–8: there is no record of its scale.

[4] Santarem Essai sur Hist Cosmog, v 1 p 358.

[5] P 21 for Chinese; below pp 296 and foll'g for those in Europe: also below p 262.

It is unnecessary to multiply mentions of maps; but there is one other which indicates common use in ships: Christine de Pisan born in Venice in 1363 tells us Aristotle says, "Those who go on the sea and do not know all the dangerous passages should have them painted on a chart to be able to avoid them and that this should do he who conducts an army or commands it."[6] Aristotle died 322 B C. I have not been able to find these words in Aristotle's works but Christine may have used a copy now lost. She was interested in many things and has been called the first modern woman. If Aristotle meant that seamen who do not know localities must learn them from charts while those knowing them require no aid he wrote as a ship-master of today would; and if this was a view generally subscribed to before 300 B C what is to become of the assertion commonly made that ships had no charts until many centuries later. In former days the ancients were depended on a great deal, in our own it has become usual to ascribe all accomplishment to the moderns.

BEFORE MAPS WERE MADE RECKONINGS OF SHIPS HAD ACCUMULATED.

Men make maps when they learn the shape and situation of land and water, which knowledge they acquire when in primitive state. They learn how small areas near their dwelling-place are formed by walking over them and large areas by sailing in ships to them and returning with accounts of directions and distances sailed. It is impossible to become familiar with large areas and map them by walking in them and when ships' records first became available for this purpose shipping and sea-faring were already organized for the mark showing where ships reach this state is to be set when they go *and return.* Until they can go and return with record showing the situation of the place visited there is no geography: map-making and geography are twin-born; born of an adult mother, the logs of ships.

Such things are not quickly accomplished. All ships that sailed out from home did not bring back courses and distances. When the grain-ship of Lucian mentioned above was blown to the coast of Phenicia, she perhaps, if the wind was strong and the pilot and skipper not lion-hearted, lost all reckoning, and knew where she was only very generally until some head-land was recognized. In former days and until after

[6] Nouv Coll des Mem pour Servir a Hist de France, x x x x x x Michaud et Poujoulat; where tomes 1 & 2 ser 1 & 2 is the Livre des Fais et Bonnes Mœurs du Sage Roy Chas V par Christine de Pizan; pt 2 chap 31. It is in old French with trans into mod French. The Coll is in the Boston Pub Library and may be elsewhere.

1750 A D ships losing reckoning a correct and full list of courses and distances were indeed lost; more than if at later period their chronometers stopped. Early ships could ascertain latitude by observation and did this if their pilot were of scientific turn but were helpless in regard to longitude their other leg until about 1750 A D. One Dion put off from Zante for Cape Passaro in Sicily in 356 B C with 2 round-ships each carrying 400 men: they, " Put off to the main sea "; straight across W S W 280 miles. Nicias made the same voyage by coasting all the way around with his great fleet of long- and round-ships 60 years before.[7] With a gentle north wind the *etesian* it being summer Dion made Passaro in 12 days; he passed along the south shore of Sicily and being caught by a gale from the north, "So tempestuous that the affrighted sailors knew not where they were," was driven south and made the coast of Africa: here, " They were informed by a vessel which accidentally came up with them that they were at the head of what is called the Greater Syrtes "; that is they were 250 miles S by W of Cape Passaro. Their reckoning has been restored by the ship met; she rendered a greater service than a vessel that gives the hour at Greenwich or Washington to a ship whose chronometers have stopped, and position on the chart could now be pricked off. It is not too much to say that as the sailors knew not where they were when the ship had been staggering before the wind in a great sea for days they usually kept reckoning and pricked off position on the chart regularly. A gentle breeze now sprung up from the south, " After an easy passage of 5 days they arrived at Minoa a small town in Sicily." This was there they wished to go. How could the ship have shaped her course from the Greater Syrtes to Minoa unless she had a chart and how could such a chart have existed unless a ship had made a survey here? [8]

TWO VOYAGES IN 200 A D.

There are 2 voyages in the writings of Achilles Tatius whose date is 200 A D the same as Lucian; one from Berytus to Alexandria 300 miles performed in 3 days and the other from Alexandria to Ephesus 600 miles performed in 6 days. The vessels were round-ships and went directly across to their destination; they were large and comfortable and passengers had private cabins. In this is the following description of a storm at sea, " The sailors xxxxxx furled one side of the sail by great exertion but were

[7] Above p 143.

[8] See Plutarch Dion for this voyage.

compelled by the violence of the wind to leave the other unfurled": the cargo was thrown over-board; passengers and crew took to the boats—but whether these were towed or hoisted is not mentioned—and the ship foundered.[9] The author of a book intended to reconstruct the life of the ancient Greeks had probably the above passage in mind when he wrote, "In vain did the sailors attempt to take in the canvas. On one side only they succeeded but this only increased the danger xxxxxx; 'Open the oil-jars' exclaimed a voice above the rest 'and smooth the seas.'"[1] There would be no alarm because one side only of a sail was furled for in heavy weather one side has always been set or taken in at a time: as the old saw has it;

He who strives the tempest to disarm
Must never first embrail the lee yard-arm.

That is when blowing hard the weather side of a sail is clewed-up first then the lee side; conversely the lee side is set first and when drawn home and steady in the wind the weather side.

THE SMOOTHING EFFECT OF OIL ON WAVES.

Becker is right in representing the ship as carrying a cargo of oil for oil was much carried over-sea in ancient days. He is right too as to early knowledge of the smoothing effect of oil: Homer wrote, "Yet doth he not mingle with the silver eddies of Peneios but floweth on over him like unto oil."[2] This puts it back to 900 B C but it is not clear Homer refers to use of oil on the sea. Aristotle about 350 B C writes that when oil is put on the sea, "The wind sliding easily over the oil which is smooth and polished has no hold and so makes no agitation."[3] The reason oil smoothes the sea has only in modern days been learned. Though rarely of use to ships the phenomenon has been much commented on; Pliny says, "Everything is soothed by oil and this is the reason why divers send out small quantities of it from their mouths because it smoothes every part which is rough."[4] About 570 A D the pilgrim Antonius of Placentia writes of the, "Island of rock oil" near the port of Suez in Egypt famous for xxxxx calming the

[9] Hediodorus Longus and Achil Tatius Bell pp 393, 399, 446–8. See pp 204 and foll'g for Lucian's voy of same date.

[1] P 115 Eng trans Becker Private Life Anc Greeks,

[2] Iliad p 44 trans Lang Leaf and Myers, 1883.

[3] Plutarch 25 vs trad Amyot v 19 p 236 ed 1820; v 2 Œuvres Mêlées de Plut; where are selections from Aristotle.

[4] Bk 2, 234, Bostock & Riley Trans.

sea.[5] The Venerable Bede relates that Bishop Adain gave travellers about to start on a journey in 650 A D some holy oil saying, "I know when you go abroad you will meet with a storm and contrary wind but do you remember to cast this oil I give you into the sea and the wind shall cease immediately."[6] In the place here cited it is stated Benjamin Franklin discussed the phenomenon with friends in 1750.[7]

VOYAGES IN THE FAR EAST.

The voyages given and facts regarding ships are drawn thus far from the Mediterranean world. We have record of a voyage before 500 A D in Far Eastern waters; that of Fa Hian a Chinaman who came to India and Ceylon on a religious mission in 400 A D, coming by land and returning by sea.[8] Fa Hian sailed from the mouth of the Ganges in the winter and the wind being favorable reached the Kingdom of Lions [Ceylon] in, "14 nights and as many days." The distance is 1000 miles, so the average day's-run was 70 miles. Leaving Ceylon he embarked, "Onboard a large trading-vessel capable of accommodating more than 200 men. Astern was towed a small vessel to provide against dangers of the sea. With a favorable wind they proceeded eastward 2 days when they were over-taken by a hurricane. The ship took in water and the merchants were anxious to board the small vessel but the crew of the latter fearful of over-crowding cut the tow-line. x x x Fa Hian worked with the crew in pumping out water and all superfluous of his own he cast into the sea." The words within quotation marks are Fa Hian's, being from the Chinese original. He gives courses and distances, so far in such direction naming only the 4 cardinal points and 4 midway between. He seems to have saved his religious objects, books and images. His allusion to throwing overboard everything of his own superfluous means probably clothing and food, for passengers have in all days brought their food onboard.

The narrative goes on; "The sea was vast immense shoreless, neither the east nor the west were known, the course was regulated by the sun the

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[5] Beazley Dawn Mod Geog v 1 p 120.

[6] Fam Quotations Bartlett 1903 p 717 note, quoting from Eccles Hist bk 3 ch 14.

[7] Sparke's ed Franklin's Works v 6 p 354.

[8] Travels Fa Hian and Sung-yun Buddhist pilgrims from China to India 400 and 518 A D trans from Chinese by Beal London 1869; Pilgr Fa Hian from the Fr ed x x x x x of Remusat Klaproth and Landresse with add notes Calcutta 1848; Journ As Soc Grt Brit & Ireland v 5 1839 Wilson. The first is the most complete; this and the work of 1848 give tracks of Fa Hian by ship from the mouth of the Ganges to southern India and thence to Java and Kouang Cheou that is Canton. It is not certain of what nations the ships were in the parts of the voyage, but Wilson thinks the first was Hindu and not Arabian.

moon and the stars. When the weather was cloudy or rainy there was no help but follow the wind. xxxx When the sky had become serene they then knew to steer easterly and proceeded afresh on their route. xxxxx Thus it was for 90 days, when they reached the Kingdom of Ye-pho-thi [Java]." After a sojourn of 6 months until the S W monsoon set in they, "Proceeded anew with merchants in a large vessel capable of holding 200. Taking provisions for 50 days we proceeded N E towards Kouang-Cheou [Canton] x. x. Provisions and water became exhausted, when 70 days out we used salt-water for cooking and divided the fresh-water. xxxxxx When this was nearly all used the merchants took counsel together and said, 'The time calculated for this long passage may be 50 days to reach Kouang-Cheou; now many days have elapsed since that term was passed; our resources are expended; it were better for us to steer N W in quest of land.'"

This because of early date and completeness is among the most interesting records we have. It is very like those of the West: a ship carries 200 passengers who take their own food onboard and probably water as well since they divided this when the supply grew short; ships follow the wind in cloudy weather; merchants meet in council to decide on the ship's movements: all these apply in the West as well as East until long after Fa Hian's day. It is the longest voyage of which we have record until much later; about 1000 miles S by W in 14 days in one ship with the N E monsoon the ship being perhaps Hindu but more likely Arab; then 1500 miles E by S in 90 days the ship being Malay Arab or Chinese with the S W monsoon; then a wait of 6 months for the N E monsoon to set in and blow itself out; and then a run of 2500 miles—the ship went north of Canton—N by E in 70 or more days. The last part of the voyage was almost certainly in a Chinese ship.

VOYAGES OF RELIGIOUS PILGRIMS.

Religious pilgrimages have led to much travel by sea. Christians men and women began to go to Palestine from nearly all parts of Europe in early days and after 320 A D when St Helena, the mother of Constantine the Great who moved the Roman capital to Constantinople, went thither their number was much increased. The tales of some have been preserved [9]

[9] See Beazley Dawn Mod Geog v 1 p 53 and following; Lib Pal Pilgrims Text Soc; Early Travels in Palestine etc Wright. Information regarding distant lands not always visited came from pilgrims; St Jerome who died at Bethlehem 420 after telling of reaching the Indian Ocean at the mouth of the Red Sea goes on, "Across this ocean you will scarcely reach India after a year's continual sailing and come to the Ganges River xx;" Wanderings Felix Fabri v 2 p 572 Lib Pal Pilgrims' Text Soc.

but though nearly all went by sea a part at least of their journey they left little account of ships.

The people dwelling near what became Venice later began to follow the sea at early date and to their ships fell most of the carrying trade to Palestine. Cassiodorus minister to Theodoric leader of the Ostrogoths wrote to Venice about 490, " You have many vessels. xxx Hasten to effect the transportation. The voyage will be easy for you because you are in the habit of making long voyages. The sea is your home you are familiar with its dangers. xxx Your fisheries suffice to nourish all your inhabitants. xxx People cannot do without salt though they can dispense with gold."[1]

SHIPS WORKED TO WINDWARD AND LAY-TO IN GALES IN VERY EARLY DAY.

It has been pointed out that ships from an early date used rigging both running and standing like what we employ.[2] They could sail by the wind and work to windward probably from the time sails were first spread; if the wind hauls and sail lifts what so natural as to haul in the sheet or brace up the yard of a square sail, if it hauls quickly and enough to catch the sail aback the ship tacks herself. The yards at head and foot of sails of Hatshepsut's ships show craft of her day sailed near the wind.[3] There are allusions to beating to windward in early times: Theognis born about 570 B C materially earlier than Herodotus writes,[4]

" Wearied and sick at heart in seas of trouble
I work against the wind and strive to double
The dark disastrous cape of poverty;"

and Sophocles about 500 B C says,[5]

" Whoever manages a vessel having drawn firm
The sail-rope gives no way; he upsetting her xx."

There are mentions of sailing close-hauled in later days, as for example in 200 B C and 75 B C.[6] Beating to windward brings to mind bowlines.

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[1] Hist Venise Daru 1826 3d ed 8 vs v 1 p 21. See also Hist Commerce de Toutes les Nat Scherer trans from German 2 vs.

[2] P 92.

[3] Above p 28.

[4] Hesiod Callimachus and Theognis Bohn p 482: see pp 467–493 for other matters of interest; and just below as to St Paul's ship.

[5] Trad Sophocles Bohn 1849 p 185, Antigone. See p 129 above for another interesting passage in Sophocles.

[6] P 425 v 2 Com Plautus; p 12 Poems Catullus; both Bohn.

These are not mentioned by name but are shown on old coins.[7] In fact both standing and running rigging of ancient ships was like our own; there were stays forward and backward shrouds on which were ladders to go aloft and lifts braces tacks and sheets brails clew-lines and bowlines. All are shown in pictures; but might be presumed for without them only small sails can be handled. The Greek and Latin names for ropes have been identified and will be found listed in books regarding ancient ships.[8]

FRAMING SHIP'S HULLS AND MASTING.

The manner in which ships were framed will be found in the books cited in the note above and will not be entered on here. There is one detail which may be mentioned, the more that it appears to have been generally over-looked. It is as follows;

> " Go now go trust the wind's uncertain breath,
> Removed four fingers from approaching death,
> Or seven at most where thickest is the board;
> Go with provision biscuit brandy stored." [9]

These lines indicate that passengers carried their own food onboard round-ships, in long-ships passengers and crew landed for meals and bought and cooked their food onshore; only in mediæval days was this custom done away. Round-ships used square and long-ships fore-and-aft sails; so the last looked higher on the wind but they were round under-water and shallow and very leewardly. They had no keel so they could easily be drawn ashore and there is no mention of weather-boards of any description though primitive people in many parts of the earth use these to prevent vessels sagging to leeward. It is curious that the so-called *lateen-sail* of the Mediterranean the fore-and-aft sail should have acquired a name derived from the word Latin, for they were used by earlier peoples before the Latins adopted them. Round- and long-ships used oars or sails as convenient; long-ships using sails when possible and round-ships oars in entering and leaving harbors or when there was no wind. The appearance of the 2 types proceeding with oars was very different: Aristotle 350 B C

[7] Cartault Triere Athen p 199; cuts are given.

[8] Serre Mar de Guerre; Cartault Tr Athennienne; Vars Art Naut dans l'Antiq.

[9] Satires Juvenal Bohn pp 137–44: his date is 100 A D. A few lines beyond is this, " And the shorn sailors boast what they endured: " the Apostle Paul being at Cenchræ the sea-port of Corinth to the east, " Sailed thence into Syria xx having shorn his head in Cenchræ for he had a vow "; Acts, 18, 18.

writes that the flight of certain insects, "Is heavy their wings small and frail and so the flight they use is like a round-ship attempting to make its voyage with oars."[1]

LYING HOVE-TO IN GALES.

Lying close to the wind and tacking was alluded to just above. In the article *Ship* in Smith's Dictionary of the Bible it is stated of the ship in which St Paul was wrecked, "The ship could not hold her course which was W by S from Cnidus by the N side of Crete against a violent wind blowing from the N W, and consequently ran down to the east side of Crete and worked up under the shelter of the south side of the island." To have gone north of Crete the ship must have made good a course within 5 points of the wind, and he would be a bold man who would undertake to do this even with fore-and-aft sails and St Paul's ship carried a square sail. In the same article the ship being under the lee of the Island of Clauda it is stated, "It is here St Luke uses the vivid term *antophthalmein*. xxxx Hence the vessel was lying-to on the starboard tack xxxx."[2] This word means to *look in the face;* the ship was looking the wind in the face, lying close to the wind with the sail often lifting and nearly stationary in the water as ships lie-to in gales now.

SPEED.

Herodotus says ships make 130 miles in 24 hours under sails.[3] Pliny writes, "Many authors have represented the entire length of the Indian coast as being 40 days' and nights' sail and as being from north to south 2850 miles."[4] This makes a day's-run 71 miles and Pliny must have had round-ships in mind for long-ships did not make voyages of this character and must have deemed a passage of 40 days' duration not unusual. The 2 statements are at first sight not in agreement, but the last means an average in several days while Herodotus means a straight-away run with fair wind, and so taken the statements are reasonable and would apply in our day. Thucydides says of the voyage from the city of Abdera to the mouth of the Danube, "By the shortest way it is a voyage of 4 days and 4 nights for a round-ship supposing the wind to be always steady astern. By land

[1] Works trans Smith and Ross De Incessu Animalium p 710 a 20.

[2] The passages are Acts, 27, 7 and 14–17. See p 204 above for abstract of St Paul's voyage.

[3] Above p 38. Cartault Triere Athens pp 251–6 has a résumé concerning speed.

[4] Pliny Bohn in 6 vs v 2 p 38.

taking the shortest way xxxxx a quick traveller performs the journey in 11 days." [5] The distance by sea is 550 miles and the ship's speed would be 140 miles per day, the average per hour 5¾. The distance by land is materially less than by sea. Evidently a continuous voyage with steady wind for 4 days and nights is what Thucydides had in mind.

THE SHIPS THAT BROUGHT FOOD TO ROME.

The coast cities of ancient and mediæval days depended on over-sea supply of food and Mommsen says that from the beginning of the Punic Wars 264 B C when the population of Rome was more than a million corn was furnished free or at low cost; "Bread for nothing and games forever" became the cry of the people.[6] Thus it was that the corn brought was a government matter and its record has been preserved. From the first difficulties arose; Augustus the first emperor established soon after accession 3 permanent fleets of war-ships to check pirates preying on ships bringing food,[7] and the facilities of Ostia at the mouth of the Tiber below Rome were increased in 42 A D; a breakwater being built and on an artificial island a light-house placed [8] in imitation of the one which had stood 300 years at Alexandria. To show there was depth of water in this harbor Pliny says an obelisk came from Egypt to Ostia in 40 A D and of the ship says, "120000 *modii* of lentils formed its ballast. xxx xx It took the arms of 4 men to span the girth of its mast." [9] This would be about 1000 tons of ballast and a mast 7 feet in diameter; it was a single stick of a fir-tree not built-up.

THE TONNAGE OF ROME'S FOOD FLEET.

Tacitus says in the reign of Claudius 41–54 A D, "The census of the citizens was 5984072" [1] and from this the ships required may be estimated. If each person had ½-pound per day the daily need was 3000000 pounds. If the hulls of the ships weighed twice as much as the cargo carried a total

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[5] Bk 2, 97.

[6] Hist Rome Eng trans v 3 p 40. See p 75 same v Corn Supply, also word *Frumentariæ Leges*, Smith's Dict Gr and Rom Antiq.

[7] Above p 169 n 5.

[8] Dio's Rome Foster ed in 6 vs v 4 p 405: same v pp 103, 194, 434 as to food supply. Pliny says v 2 p 467 Bohn oysters were brought from abroad to Rome: his day was 70 and Dio's 250 A D.

[9] Pliny Bohn in 6 vs v 3 p 419. On the next p a mast 130 feet long and requiring 3 men to span it is mentioned: see above p 205 as to these masts.

[1] Ann bk 11, 25; p 265 v 1 Bohn in 2 vs.

of 9000000 pounds or 4500 tons in displacement must dock at the port of Rome in each day. This would require 45 ships of 100 tons; or if we assume ships of 500 tons when loaded which is probably nearer to facts 9 ships must arrive each day; about one ship each hour of daylight. If the ships procured corn in Egypt and the voyage complete occupied 50 days the service would call for 450 ships. If the corn came from Africa as it did in part and the voyage occupied 25 days 225 ships of 500 tons could perform it. All way to the place where the corn originated there would be a line of ships a few miles apart. Even if half came from Sicily by wagon from the Strait of Messina or parts of Italy near Rome anxiety regarding supply must have been ever-present.

We may believe Tacitus when he says, "It is certain there was then in Rome provision only for 15 days and it was by the singular bounty of the gods and the mildness of the winter that the public was relieved in its urgent distress;" and, "In former days the distant provinces were furnished with supplies from the districts of Italy, xxxxxxx but now we choose to ply Africa and Egypt and the lives of the Roman people are made dependent on ships and casualties."[2] This state lasted for centuries: Ammianus Marcellinus a Roman author writes that in 359 A D,[3] "The Eternal City was fearing distress from an impending scarcity of corn; xxxxxx the provisions were embarked in ships which xxxxx were driven into any port they could make. xxxxxx The prefect of the city was at Ostia sacrificing in the temple of Castor and Pollux when the sea became calm the wind changed to a gentle south-east breeze and the ships under full sail entered the port laden with corn to fill the granaries." All cities were dependent on ships and the Peloponnesian War turned upon food-supply: Thucydides makes an orator tell the Spartans the principal foe of Athens,[4] "It is not in Attica that the war must be decided xxxxxx but in that quarter whence Attica derives its succors." Nor was the condition soon changed: 75 years after this war Athens fitted 200 war-ships a very large fleet and sent it northward to prevent Philip of Macedonia stopping her corn-ships coming from the Black Sea.[5]

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[2] Ann bk 4, 5; 6, 13; 11, 25. The statements fall in the reigns of Tiberius 14–37 and Claudius 41–54.

[3] Hist trans Yonge 1887 bk 19, 10: the author died about 380.

[4] Bk 3, 13. See also Grundy Thucydides and Hist His Age, chap on Food Supply; Gernet Approvisionnement d'Athene en Ble.

[5] Or Æschines vs Ctesiphon and Demosthenes etc trans Portal p 254.

VOYAGES IN THE WINTER SEASON.

In the quotation from Tacitus given it will be noted the corn-ships came during winter. In the service the ships operated throughout the year and Thucydides mentions several winter passages, some of fleets of long-ships, which would require greater hardihood than the passage of round-ships singly.[6] Plutarch in his Life of Pompey writes of the pirates, " Even the winter season did not give protection against them; " that is corn came during the winter and the pirates captured the ships. Pliny writes, " The spring opens the season for the navigators. xxxxxxx Yet the severity of the storms does not entirely close up the sea. In former times pirates were compelled xxxxxx to brave the winter ocean, now we are driven to it by avarice;"[7] a reasonable statement implying round-ships were on the seas throughout the year. The Roman poet Horace writes just before Pliny's day, " Severe weather is melted away, xxxxxx and the engines haul down the dry ships."[8] In Vegetius a Roman who wrote 375 A D we read,[9] " From Nov 11 to March 10 the seas are entirely shut up." Perhaps by the day of Vegetius in the political and industrial decay of Rome ships no longer kept the sea in winter or cities numbered fewer persons.

As already remarked wood ships lose speed when long in the water and this probably led to ancient ships being periodically hauled on land. Hulls were not as stiff as now and caulking not as good and sometimes dropped out. Athenæus tells of lead strips on ships in 250 B C [2]and in a vessel sunk 100 A D and recovered 1300 years later we have the same: as to the last John Locke an Englishman who wrote in 1704 says,[3] " Alberti in his Book of Architecture has these words,[4] ' But Trajan's ship weighed out of the Lake of Riccio at this time while I was compiling this work where it had lain sunk and neglected for above 1300 years xxxxxx was built with double planks daubed over with Greek pitch caulked with linen rags and

[6] Bk 7, 10–16; 8, 39. Cæsar crossed the sea with an army during the winter several times; above p 192.

[7] Bohn ed v 6 p 77.

[8] Smart's trans Bohn bk 1 ode 4: the words are also p 163 n 2 above.

[9] Mil Inst Clarke trans 1767 p 203.

[2] Above p 79.

[3] Hist Nav 2 vs Paris 1772 v 1 p 47. There is an Eng ed. See p 350 below as to lead strips to hold caulking in.

[4] Lib v cap 12: there is an Italian trans 1833 of the Latin work: Alberti's day was 1404–1472. Riccio is a small lake 40 miles north-east of Naples. Trajan was emperor of Rome 100 A D.

over all was a sheet of lead fastened on with little copper nails. xx xxxx.' Here we have caulking and sheathing together above 1600 years ago."[5]

WAS THERE A DARK AGE FOR SHIPS?

There appears no indication that during the Dark Ages, from say 400 to 900 A D, ships and sailors lost efficiency. All cities fell away in trade and population and ships were fewer; Rome lost hold on outlying districts and state emissaries the curious and learned travelled less; Rome sent no fleets to distant provinces; there were no long voyages made to extend trade which fell off everywhere; but that ships in the Dark Ages were less well built than before or after less well sailed or seamen lost skill or hardihood there is no evidence. The Dark Ages perhaps little affected material things though progress in development of thought was arrested.

MEASUREMENTS OF THE EARTH BY THE ANCIENTS; THEIR VIEWS AS TO CIRCUM-NAVIGATION.

Though not the first to make the attempt Eratosthenes a Greek born 276 B C measured the earth's size. He made its circumference 250000 stadia, 25000 miles if we take 10 stadia to a mile; a result $^1/_7$ in excess.[6] This he did by (1) assuming the city of Syene in Egypt on the Tropic of Cancer, (2) measuring the latitude of Alexandria by observing the shadow of the sun with an astrolabe or gnomon, (3) assuming Syene and Alexandria in a north and south line, (4) assuming the two cities 5000 stadia apart. It is said he found the difference of latitude between Syene and Alexandria $7^1/_5$ degrees, $^1/_{50}$ of 360 degrees, and from this calculated the circumference at 5000 x 50, 250000 stadia. The method would be followed now. Several mistakes were made if our account is correct; Syene was not on the Tropic of Cancer;[7] Syene and Alexandria were not in a north and south line; the distance stated between the 2 places, 5000 stadia, we cannot examine because we do not know the length of a stadium. To determine the 2 places were north and south of each other appears at first a matter of

5 A search for further information about this vessel has failed; it might be successful in Italy: what was her length depth width how was she rowed etc? She was probably not sea-going.

6 Bunbury Anc Geog v 1 p 625.

7 We are not told so but it looks as if this may have been assumed without observation: the ancients knew bodies were exactly in the zenith by catching their reflection in the water in a well; in effect what we call an artificial horizon. But although this would give accurate determination error was made for the ruins of the ancient city of Syene are 24° 06′, the Tropic of Cancer 23° 30′.

longitude and this could not be accurately measured; but such is not the case. A north and south line could have been drawn from Alexandria or Syene by setting up posts as far apart as observers could see and lining them north and south by the pole-star or other celestial body. After 2 posts were set up true others beyond would be lined on them.

We have to examine Eratosthenes' latitude of Alexandria and the distance he used between that city and Syene: the first he could determine by gnomon or astrolabe and by other means; the second, the distance, he derived perhaps by sending men to pace it. Possibly he had it measured as we would today; by measuring the angles and sides of one triangle across which observers could see and measuring by a tape one side of this and then proceeding to determine the parts of more triangles across which observers could see until the entire distance between Syene and Alexandria was gone over; observing in additional triangles only angles and deriving the length of sides by computation or construction. This process we call triangulation: it was understood before the day of Eratosthenes.

Eratosthenes' measurement could have been and perhaps was as accurate as we might make today; but we do not fully understand the account and some conclude it primitive. We know now the length of a line north and south around the world through Alexandria is not quite the same as others around it but otherwise our knowledge is the same as that of Eratosthenes, and in such measurements we would do better than he did because our instruments are nicer and read closer.[8] The writings of Eratosthenes have not been found and most of what we know of him comes from Strabo a Greek geographer of 200 years later date. The latter quotes him as having stated the distance from the Atlantic coast of Spain east to the extreme East at 78000 stadia; leaving 172000 stadia westward from Spain to the extreme East: the last was conceived to be sea for nothing was known of the American continent. Eratosthenes said of this space west,[9] "If it were not that the vast extent of the Atlantic Ocean rendered it impossible one might even sail from the coast of Spain to that of India along the same parallel." That is a ship might steer west from Spain about 17000 miles and reach Asia: as to this; (1) Eratosthenes did

[8] Examination of this measurement will be found pp 619–625 v 1 Bunbury Anc Geog; note 7 p 621 states the source of all we know about it.

[9] Strabo Bohn in 3 vs bk 17, 1, 48: Bunbury Anc Geog v 1 p 627. There is everywhere evidence of maps: Strabo tells (bk 2, 1, 2) of Eratosthenes, "He then declares the ancient geographical chart wants revision:" see Bunbury v 1 p 619 notes 2, 3. See below p 541 as to importance of this measurement to Columbus: the correct distance west Spain to China is about 13000 miles.

not know that west winds prevail so far north and that a ship must go south into the trade to make good speed west-bound; (2) he deems 17000 miles too long a run for a round-ship. Continuous runs as long—an Atlantic port to California or China, Australia to Atlantic port, etc,—have been common for modern sailing-ships; and though the last are stauncher and more seaworthy than ancient round-ships, these could have made such a passage with reasonable probability had there been an object in doing so, for they could carry the food and water necessary.

One hundred years after Eratosthenes another Greek Posidonius measured the earth using the difference in altitude of the star Canopus as seen at Rhodes and Alexandria and taking the distance measured by ships between Rhodes and Alexandria. They do not lie north and south, which could have been determined by the reckonings, for the line between them is 22 degrees out from north and south. It cannot be Posidonius did not comprehend so simple a matter and its consequences, but is not written in the account we have that correction was made for this. We know only that Posidonius employed the runs of ships between Rhodes and Alexandria and can hardly accuse him of not securing from ships the bearing between the two. In other words Posidonius believed ships could keep accurate records of courses and distances run.[1] Regarding his measurement Posidonius says, " The length of the inhabited earth is about 70000 stadia being half of the whole circle on which it is taken; so that starting from the west one might aided by a continual east wind reach India in so many thousand stadia." [2] Posodonius is in error in his result for from the Azores east to the Peninsula of Malacca the west and east limits of earth-knowledge of the day is 130°; little more than $^1/_3$ not ½ the circumference. Pliny 150 years after Posidonius states a measurement of what he calls, " Our part of the earth " to be given just below which agrees with Posidonius' measurement.

As in the determination of Eratosthenes so in that of Posidonius the

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[1] Those who wish to estimate the science of the ancients should read the work of Euclid of 200 years before Posidonius; it excels in close reasoning. To Posidonius came ships' reckonings, logs, many of them, for ships had been on the ocean-route Rhodes to Egypt 1000 years by his day; these gave courses and distances run or the time during which they were steered; the courses and distances were probably not reduced as they would be today to differences of latitude and longitude. Can any-one doubt our astronomer used this correctly?

[2] Strabo bk 2, 3, 6 Bohn ed. By " Length of the inhabited earth " Posidonius means the length east and west of the part of the earth known in his day, a rectangle longer east and west than north and south. Our word longitude is from the Latin *longitudo,* length; latitude is from *latitudo,* breadth. See Bunbury Anc Geog v 2 pp 95–97 as to Posidonius' measurement.

account is so imperfect it is impossible to say where error is. Posidonius is said to have concluded the altitude of Canopus the star he used differed by $7\frac{1}{2}°$ as seen at Rhodes and Alexandria. This is $^1/_{48}$ of 360° and since his conclusion is that the circumference is 140000 stadia and 3000 is nearly $^1/_{48}$ this, it follows that the distance reported by the ships was 3000 stadia: 300 miles if we take 10 stadia to the mile. At least 2 mistakes were made, (1) the latitudes of Rhodes and Alexandria are 36° 27′ and 31° 12′ and the difference betwen them and in altitude of Canopus as seen from them is 5° 15′, $^1/_{69}$ the circle not $^1/_{48}$; (2) the correct north and south distance between the 2 is 315 miles and if Posidonius had used this figure and 5° 15′ for difference in height of Canopus his circumference would have worked out 315 x 69, 22000 miles; very nearly correct.[3] He could not have erred so much as to suppose the difference in altitude of Canopus, in fact $5\frac{1}{4}°$ was $7\frac{1}{2}°$; if he did not but used a figure approximately correct $5\frac{1}{4}°$ or $^1/_{69}$ the circle and reached as we are told was the case 140000 stadia as the earth's circumference, then the distance the ships reported was not the true one 315 miles but about 200. This error is large enough to give reasonable cause to reject this supposition: ships could not have erred as to times on courses or distances on them by ½. The conclusion is we cannot satisfactorily examine Posidonius' work: the record is instructive however as to the ways of ships.

As stated Pliny gives a measurement from the Azores or the Pillars to the east, calling this " Our part of the earth " and putting the boundary eastward at the Ganges. He gives 2 measurements one by land and one by sea which last he says is the less accurate; each is composed of a number of distances but he does not give the directions of these, their courses. The distances by land total 8945 miles and by sea 8568; while the actual distance a ship must sail from the Ganges to the head of the Red Sea thence by land across and then on by ship to Gibraltar, allowing nothing for divergence from a straight course is 8000 miles.[4] We shall not come upon another measurement eastward for many centuries:[5] the later ones depend also on runs of ships. Most of us live on the land and win our daily bread from it but the situation and shape of lands are determined by the sea and upon the sea the science of geography rests. The Great Ocean Voyages were very great events the full consequence and purport of which it is hard to realize. Who would write today as Aboulfeda a man of science wrote

[3] The greatest circumference is about 25000 *statute*, 22200 geographical or sea miles.
[4] Bohn in 6 vs v 1 p 143: the distance given is taken from a modern map.
[5] Below pp 234–5, 237.

about 1300 A D, " Sin [China] is bounded on the east by the eastern Atlantic." [6] If we wrote Atlantic in this connection we should call it western.

STRABO WRITES THAT CIRCUM-NAVIGATION HAD BEEN ATTEMPTED.

A very remarkable statement is made by Strabo: that by his day 10 B C attempts had been made westward from the west and eastward from the east to circum-navigate the earth; "In the west," he writes, "The land occupied by the Iberians and Maurusians is wholly encompassed by water and so is the greater part of the north and south. And as to what remains as yet unexplored by us because navigators sailing from opposite points have not hitherto fallen in with each other it is not much as anybody may see who will compare the distance between those places with which we are already acquainted. Nor is it likely that the Atlantic Ocean is divided by narrow isthmuses so as to prevent circum-navigation: how much more probable it is confluent and uninterrupted. Those who have returned from an attempt to circum-navigate the earth do not say they have been prevented by any opposing continent for the rea remained perfectly open but through want of resolution and scarcity of provisions. x x x" [7] The only way to interpret this, involving conviction attempts to circum-navigate the earth had already been made, is impossible. It brings out clearly how necessary the Great Voyages were in the growth of geography; even to imagine the earth Strabo invokes the aid of ships. There is a similar passage more often referred to than that of Strabo and of prophetic character in Seneca's Medea; its date is 50 A D, less than 100 years after that of Strabo; " Now in our time," it reads, " The deep has ceased resistance and submits utterly to law; x x x and little craft now wanders at will on the deep. All bounds have been removed x x and the world now passable throughout has left nothing where it once had place; the Indian drinks of the cold Araxes the Persians quaff the Elbe and the Rhine. There will come an age in the far-off years when ocean shall unloose the bonds of things, when the whole broad earth shall be revealed, when Tethys shall disclose new worlds and Thule not be the limit of the lands." [8]

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[6] Extr from Aboul Yule's Cathay 2 vs p cxciii v 1. The Geog of Aboulfeda has been translated and published.

[7] Bohn bk 1, 1, 8.

[8] Pp 364–80, 259–60 v 1 trans Miller 1917. The Araxes emptied into the Caspian, Tethys was the goddess of the sea, and Thule the extreme north or the uttermost limit of the earth. At almost any opening the Medea has allusion to the sea; one regarding Tiphys helmsman of the Argo is given p 197 above.

CHAPTER VI.

ROUND-SHIPS IN THE EAST.

500 to 1500 A D: Ships and Voyages, Astrolabe, Compass, Ephemerides.

From early date ships of Arabia Persia China and near-by islands were alone in the oceans east of Africa and south and east of Asia, and because these oceans are very large and ports far apart made voyages unheard of in Europe, the steady winds of the region having much to do with this: the condition was not disturbed until Portuguese ships came to the East in 1498 when the havoc wrought in native seafaring was immediate and great but impossible to estimate otherwise than generally. Facts of geographical character were drawn from seamen and travellers visiting the East. Ptolemy about 150 A D placed Sinæ where China is and the great sea-port Cattigara in fact non-existent on the west shore of an imaginary continent drawn where Java Sumatra and other islands are. His knowledge of the East came from ships plying eastward and bringing to Alexandria and the world of Europe the spices and wealth of that region; but what the men in the ships told him, how far they had been and what reports they brought, there is no means of knowing. The spices used in Egypt and Europe thousands of years before the Christian Era came by ship from the East and one thousand years before the same epoch King Solomon and Hiram of Tyre fitted ships at the head of the Red Sea to go to that land of gold and fable.[9] The traffic continued to grow and we hear of it again from Strabo and the author of the Periplus of the Erythræan Sea; the former at the beginning of the Christian Era and the latter 60 years later.[1] Strabo was not himself in the East and the author of the Periplus went only as far as India but knew by hearsay of China and the multitude of islands east of Java and Borneo where are the most prized spices. Whether the spices which reached Europe 3 or 4 thousand years before the day of Strabo came from the distant islands, the Spice Islands as they were called in Europe, from near the mouth of the Red Sea, or from the coast of Africa cannot be determined.

Ptolemy's knowledge of the East came from ships reaching the head of the Red Sea; from logs of Phenician seamen systematized by Marinus

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[9] Above pp 34 and foll'g.

[1] Pp 205, 328 as to Strabo, 207 and foll'g as to Periplus.

of Tyre. He charted China about correctly but made the mistake of drawing what we call the Indian Ocean closed on all sides by land; which is the more remarkable from the fact Strabo says merchants of Alexandria had copious traffic eastward a long while before his date. Before the day of Ptolemy Christian missionaries had also penetrated Asia and their activity lasted many centuries; until now we may say.[2]

Embassies came to Europe from India and one was sent by ship to China in Ptolemy's day; some 3 centuries later the Greek traveller Cosmas visited India and monks brought to Constantinople from China the eggs of silk-worms from which has grown the silk-culture of the Mediterranean basin; later again from 700 A D on Mahometan travellers began to go in numbers to India China and the islands S E of Malacca; Moluccas and others. The last brought to Europe geographical data of these waters of accurate character. Following the Mahometans came about 1250 a great army of Christian merchants and ecclesiastics among whom John of Plano Carpini and William Rubruquis were leaders and Marco Polo the most renowned. In 1497 came Da Gama in his ships when the mysteries of the East were revealed and its geography and traffic at sea rapidly developed. Ptolemy thought he knew enough of China and the East to map it and by about 150 A D European knowledge had reached the western part of what we call the Pacific Ocean. Ptolemy's maps locate points on the east coast of Africa where also his knowledge came from ships' logs: by these he puts down Rhapta Prasum Menuthias and other places which may be identified; Menuthias is Madagascar 12° to 25° S latitude.[3] These are located by day's-runs of ships trading to these places.

COSMAS INDICOPLEUSTES.

This is our first writer after 500 A D. He was probably a Greek and was called Indicopleustes because he sailed to India in early life when a merchant. In about 550 when dwelling in Alexandria and after he had become a monk he wrote a book he called Christian Topography in which he says he sailed along the coast of *Taprobane* that is Ceylon but did not land. He did not go so far as China but says, " Taprobane being as it is in a central position is much frequented by ships from all parts of India

[2] Yule Cathay 2 vs p lxxxix, St Bartholomew was in India and perhaps China; p ccxliv the sees of early Christian bishops in Asia are shown on a map.

[3] Bunbury Anc Geog v 2 pp 452, 610, 611; Grandidier referred to p 313 below.

and from Persia and Ethiopia and likewise it sends out many of its own. And from the remotest countries I mean *Tzinista* and other trading places it receives silks aloes xxx. Beyond Tzinista which produces the silk there is no other country for the ocean surrounds it on the east." [4] Tzinista is of course China. In Cosmas' time it had become impossible to procure silk in Constantinople or Byzantium as the city was still called, because of tolls charged by the Persians who controlled the routes by land and sea by which it came. In the reign of Justinian Roman Emperor at Constantinople 527–565 some monks brought there some silk-worm eggs: Procopius who was of the day being secretary to the great soldier Belisarius wrote of this,[5] " And from this beginning originated the establishment of silk-culture in the Roman territory." There is not anything directly concerning ships in Cosmas' book. A little later than Cosmas ships of China came to the head of the Gulf of Persia and this they did no doubt in and before his day showing sea-faring in the East surpassed that of the West. Klaproth writes,[6] " The annals of China have preserved the details of the route they took during the Thang dynasty 600 to 800 A D the ships sailing from Canton for the Strait of Malacca; whence they went to Ceylon the Malabar coast the mouth of the Indus and thence to Siraf and the Euphrates. It is not likely that Chinese ships making these long voyages did not employ to direct their course the magnetized needles they knew already about the year 121 of our own era."

VOYAGES OF ARABS AND PERSIANS TO INDIA AND CHINA 850 A D.

There is a work recounting the voyages of Suleiman the Merchant and Abou Zaid Hassan of whom the former sailed from India to China before 850 A D,[7] It is clear Suleiman went by ship from India to China but his writing shows nothing more except that there were many foreign traders in Khanfou in 878 A D, for the city was captured in this year after a siege and Suleiman says of the capture,[8] " Persons familiar with the facts say there perished on this occasion 120000 Mussulmans Jews Chris-

[4] Chr Top Cosmas Hakl; Yule Cathay 2 vs v 1 p clxvii: Cathay is the name by which China was known in the Middle Ages.

[5] Bello Gothico iv, 17, Hist Constantinople Cousin Paris 1635: also Yule's Cathay v 1 p clix–clxiii.

[6] Boussole p 95.

[7] Voy Faits xx xx dans l'Inde etc trad Reinaud; Reinaud states the ms he translated was written about 1150 and the original 850.

[8] Pp 64–8 work cited preceding note; Yule Cathay p cii v 1.

tians and Magis who were established in the city in the pursuance of trade. xx xx Even for the captains of Arab vessels there was no mercy and the masters of merchant-vessels xx." The translator Reinaud deems that Suleiman's account formed the basis for the story of Sinbad the Sailor's 7 voyages recounted in the Arabian Nights; but though Sinbad is said to have gone to many places and islands south of Asia he is not said to have reached China.[9]

IBN-KHURDADBEH.

Our next author is Ibn-Khurdadbeh an Arab and director of mail routes in Media 870–885. He called his work Book of Routes and Provinces and gives advice of official character regarding merchandize in eastern ports and sailing-routes. He states the routes from Basrah and Fars both in the Persian Gulf to the Orient: "Aden is one of the principal ports in this sea," he writes, "Neither corn nor sheep are found there but amber aloes and musk abound. Aden is the shipping point of the merchandize of Sind India China Zendj Abyssinia Basrah Djeddah and Kolzoum. xx In this sea there is a fish from 150 to 300 feet long; mariners fear it. xx x In the same region is a flying-fish a foot and a half long xx;" —two marvels are interjected both being facts. Khurdadbeh gives distances from port to port along the south and east coasts of Asia and writes, "The greatest length of the China coast is 2 months' voyage. xxx It has 300 cities all prosperous and well-known. The country is bounded by the sea Thibet and the country of the Turks, strangers from India are established in its eastern provinces. xxx The length of this sea between Kolzoum and the country of the Wak-Wak is 4500 fars."[1] The translators add that 4500 fars is 2700 myriameters. The distance then from Kolzoum the head of the Red Sea to the country of the Wak-Wak is by Khurdadbeh's measurements, distances sailed by ships from one port to the next, 27 million meters, 13500 geographical miles. We do not know certainly what is meant by the Wak-Wak but it must be the Spice Islands the Moluccas east of Java and Borneo or China. The distance measured from point to point of land to either from the head of the Red Sea is about 7000

[9] Beazley Dawn Mod Geog v 1 pp 439–49. Beazley calls the Arabian Nights the Arabian Odyssey. The tales were probably put in their present form in the day of Suleiman.

[1] Ibn-Khurdadbeh Livre des Routes et Provinces trad Barbier de Meynard, Jour As Soc ser 6 tome 5 1865 pp 281, 283, 282, 294. P 293 is explanation of the tides by, "Abd el-Ghaffer the sailor from Syria."

miles. If we apply to Khurdadbeh's measurement the way of reducing distance sailed to distance made good used by Ptolemy 725 years earlier in finding distance from Palura to Curura, that is lessen it successively by $^1/_3$ and $^1/_6$,[2] the 13500 miles become 7500; thus regarded Khurdadbeh's figure is nearly right. He says nothing of reduction; does not even tell whether it had been applied. He may not have known it was necessary but ship-captains and scientific persons knew this.

This is the earliest actual measurement of the distance from the world of Europeans from the head of the Red Sea to China the eastern limit of geographical knowledge; of the year 870 A D from Arab source and measured by seamen. A modern author writes, "Ptolemy indeed knew Cattigara through account given by Marinus of Tyre. xxx It remained for the Arabs to complete the through line by opening direct communication under the Baghdad Caliphate between the ends of the earth; Lisbon and Canton."[3] Kkurdadbeh's book gives also, "Route from Basrah[4] to the East;" "Itinerary to China;" and "Itinerary of the Jewish merchants called Radanites." Radan was in Mesopotamia. Khurdadbeh says of these,[5] "They embark in the country of the Franks on the western sea and go to Farama; there they load their merchandize on beasts of burden and go by land to Kolzoum a distance of 5 days' journey and of 5 farsakhs. Then they embark on the eastern sea,[6] and go from Kolzoum to El-Djar and to Djeddah, then they go to Sind India and China. In returning xx." It results from Khurdadbeh that in 870 ships from the Red Sea and Persian Gulf went to China and Chinese ships came through in reverse direction. Suleiman says there was a massacre of Mussulmans and Christians in Khanfou in 878[7] and Masoudi, another author writing about 925, says ships from the West and China met and stopped at Kalah, "About half-way to China," because of danger at the terminii formerly frequented.[8] Kalah is thought to have been in Sumatra in the Strait of Malacca; it may however have been the city of Malacca, a place of great wealth when captured by the Portuguese about 1525.

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2 Above pp 41 and foll'g.

3 Schoff Perip Eryth Sea p 228.

4 Head Persian Gulf, seaport of Baghdad capital Eastern Caliphate.

5 P 513 work cited: Farama was near the Nile mouth, Kolzoum is Suez.

6 Red Sea; El-Djar was a port in the Red Sea.

7 Above p 233.

8 Below p 236.

MASOUDI: MEADOWS OF GOLD.

The next author is another Arab Masoudi who wrote about 925 A D a book he called *Meadows of Gold:* [9] "The astronomer Hocein author of the Book of Astronomical Tables reports," Masoudi writes, "That according to learned men who by order of Almamoun had taken the height of the sun xx the measure of a terrestrial degree is 56 miles; multiplying this by 360 they found for the circumference of the globe xx 20160 miles." [1] This Book of Astronomical Tables, Ephemeris, giving positions of celestial bodies at stated times, is the first formally mentioned in history; preceding by 400 years the tables of Alfonso the Wise [2] the first in the West. Masoudi tells of a merchant who sailed from Basrah to Kalah, "Which," he says,[3] "Is about half way to China. Today this city is the rendezvous of Mussulman vessels from Siraf and Oman which here meet the vessels from China. But this was not so formerly: the vessels of China came then in the country of Oman to Siraf on the coast of Persia and Bahrein to Obollah and Basrah; and those of these countries navigated on their part directly to China. It is only since one can no longer count on the justice of the government xx that they meet each other at this intermediate point. This merchant embarked then in a Chinese vessel to go from Kalah to the port of Khanfou." [4] Regarding the Atlantic Ocean Masoudi mentions,[5] "The inhabitant of Spain named Khachkhack a native of Cordova xx who passed into the outer sea."

Two other passages in Masoudi must be included, he says,[6] "In the Geography of Ptolemy the seas are illuminated in various colors;" showing that in his day the maps made by Ptolemy 800 years before still existed. It is not known whether the maps accompanying modern editions of Ptolemy's Geography were in truth made by him but the statement of Masoudi renders this likely; and if the maps of Ptolemy Masoudi saw were not destroyed before 1500, when editions of Ptolemy were first

[9] Prairies d'Or trad Meynard et Courteille 9 vs; V 1 pp 182, 185, 810, for the quotations following.

[1] Above pp 226 and foll'g for measurements of earlier date. Almamoun was caliph at Baghdad 825. Masoudi gives following details; "To find this measure the elevation of the north pole was taken in 2 cities on the same meridian; Tadmor and Rakkah. The elevation at Rakkah was 35¼° and at Tadmor 34°; then the distance between the 2 cities was measured and found to be 67 miles"; V 1 p 190.

[2] Below p 239.

[3] V 1 p 308.

[4] Kingsse or Hangcheu.

[5] V 1 p 258: for Edrisi's reference to the Atlantic 2 centuries later see just below.

[6] V 1 p 185.

printed, there has been no break in maps from pre-historic days until our own; their history is continuous. Masoudi says [7] the distance from the Fortunate Islands by which he means one of the groups west of Africa to China, "Is 13500 miles or 12 hours:" the accuracy of the statement will be examined presently. When measuring the altitude of the pole-star the Arabs who determined the size of the globe used no doubt a large astrolabe carried on frame-work and as the measurement could be repeated or made with several instruments their altitude was probably correct. What is said regarding trade in distant regions, the difference of longitude between the Atlantic islands and the coast of China, and the man from Cordova in the Outer Sea show the extent of Arabian sea-faring in Masoudi's day. When more than 200 years later the geographer Edrisi called the Atlantic the Sea of Darkness he indulged in extravagance. [8]

THE CALIPH ALMAMOUN.

Almamoun caliph at Baghdad when learned men measured the size of the earth and Hocein wrote his Book of Astronomical Tables reigned 813–33 being successor to Haroun-al-Raschid. Both were enlightened princes; [9] in their day learned Arabs were induced to translate Ptolemy's Astronomy and Geography and the work of Marinus of Tyre since disappeared and tables giving positions of celestial bodies were computed. In the reign of Almamoun Alfergany wrote a treatise on the astrolabe and this may have been for benefit of shipping for ships of the Arabs were to be found from the Azores to China; as far east as the Spice Islands.[1] Whether astrolabes were used in ships we do not know but they had long been available for Ptolemy had them made of light and convenient form and there are now in collections astrolabes from about 950 A D of a type which would serve at sea[2] Another very striking thing was done in the reign of Almamoun; Nov 30, 829 the height of the sun was observed at Baghdad at the beginning and ending of an eclipse to determine the

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[7] V 1 p 810.

[8] Below p 253.

[9] Libri Hist Sciences writes, "The Arabs advancing on the debris of 20 thrones became the depositaries of all known science and carried it to the West. xx Dictating peace to the Emperor of Constantinople the victorious Arabs demanded manuscripts and savants," v 1 pp 105–10. P 132 same v ascribes great antiquity to mathematical science; "Hindu astronomers had tables of sines understood spherical trigonometry xx observed the stars with instruments xx measured time knew the armillary sphere and used circles of declination xx."

[1] Beazley Dawn Mod Geog v 1 pp 49, 409–12 as to service of Almamoun to science.

[2] P 61 as to Ptolemy's light astrolabe and those in collections.

hour of these occurrences.[3] This observation is still taken at sea to fix time. We have record it was used 700 years earlier than Almamoun's day by Ptolemy for the same purpose. It is impossible that not only were instruments at hand but they were used in the way they would be at sea, and that yet seamen passed them by: it is however materially later than 850 A D that we find mention of an astrolabe or any angle-measuring instrument in a ship.

MASOUDI'S DIFFERENCE OF LONGITUDE.

Respecting what Masoudi wrote of difference of longitude and distance between the extreme West and East:—the longitude of the Azores the islands in the Atlantic furthest out is 28° W and of the east of China 124° E; thus the arc of longitude between them is 152° not 180° or 12 hours. As to the measured length given it is more nearly correct than Khurdadbeh's. The distance stated by the two is the same though the points at which measurement begins and ends are different. The direct distance a ship would sail around head-lands assuming there was a Nile-Red Sea canal from the Azores to Canton is 9000 miles; assuming as before that Masoudi's figure[4] 13500 miles is the whole distance ships sailed between intermediate places and reducing by $^1/_3$ and $^1/_6$ as Ptolemy did we reach a distance of 7500 miles; too little by $^1/_6$.

THE ASTROLABE.

The Arabs had the instruments and data necessary to make astronomical observations at sea in 800 having derived this originally from the Greeks; for they took much from the Greeks improved on it and passed it west; perhaps improved the application of astronomy to position-finding at sea for there is indication of this. In 650 a few years after Mahomet proclaimed his divine mission and before the conquests of his followers had spread their power widely a treatise on the use of the astrolabe was written in Arabic by Severe Sabokt and examination of the original manuscript and its history shows its origin is Greek and not Arabian.[5] A glance at this shows its author was a good astronomer; in it such problems as the following are solved: To find during the day by the astrolabe the solar

3 Article Time Enc Brit 9th ed. See above p 59 as to Ptolemy's determination of time by an altitude.

4 Above p 237.

5 Treat Astro of S Sabokt written in 7 Century from Greek Sources xx by Nau Journ Asiat 9th Ser tome 13 Jan-Feb 1899; Arabic with French trans: see above p 58 and below p 243 for Chaucer on the astrolabe.

hour; to find the hour during the night by the stars; to find by the astrolabe the station of the sun; to find by the astrolabe the station of the moon and the 5 planets;[6] to see if the astrolabe is true; how to know by the astrolabe which is the northern-most and southern-most of two cities; how to find the difference of noons in two cities;[7] how to find the latitude of the 7 climates; how to know by the astrolabe the longitude and latitude of fixed stars; etc.

Severe Sabokt lived 200 years before Almamoun; he writes as though he had at hand the data respecting positions of celestial bodies such as found in modern ephemerides. This puts the date of the first of these of which we have record back to 650, 200 years nearly before the similar tables of Hocein computed in the reign of Almamoun Caliph at Baghdad and 600 before those of Alfonso the Wise the first of which we hear in the West.[8] It is to be added that the last though made by order of Alfonso King of Castile and Leon were computed with the assistance of Arabs. In the day of Alfonso, 1252–82,[9] Aboul Hhassan All de Maroc a Spanish Arab wrote a treatise on the astronomical instruments of the Arabs;[1] an extensive work solving such problems as the following: determination of latitude of places by meridian altitude of a heavenly body and by other methods;[2] the time of rising setting and meridian passage of a star; the end of evening and beginning of morning twilight; the azimuth of the sun at any time; the longitude of a place on the earth; the distance between places in miles; knowing the local time to determine the hour at another place whose latitude and longitude are known:[3] these are solved graphically.

AZIMUTH; FINDING DIRECTION BY ASTROLABE.

Aboul Hhassan's treatise shows how to find azimuth. It does not name the instrument to be used but astrolabes existed in the day and it had been shown how to make them portable by Vitruvius 25 B C and again

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[6] By station is meant meridian altitude; that is standing.

[7] Here is explained the theory of finding longitude.

[8] Pp 236–7 above.

[9] In Alfonso's day King's ships had a ration of cider and wine: Alfonso ordered this discontinued; water and vinegar in certain proportions was the best beverage, most wholesome and that which will give the seamen the most pleasure during repasts he said: Las Siete Partidas Alfonso Real Acad Hist Madrid 1807 3 vs law 9 p 265 v 2; other things of interest are here given: see also Jal Arch Nav v 2 p 312 foot-note.

[1] Traité Instr Astron Arabs trad Sedillot 2 vs 1834; a French trans.

[2] V 1 p 199.

[3] V 1 pp 287, 295, 307, 312, 324, 325.

by Ptolemy 200 years later. Also there are now existing astrolabes of date earlier than Aboul's. There could be no object in finding the azimuth of a celestial body, its angle measured on the horizontal-circle from the north or south, except to establish direction; to determine as we would say the points of the compass. Severe Sabokt wrote 600 years before Hhassan and does not mention azimuth but knew how to find it. It is generally believed the compass filled an absolute void; that until its advent [4] ships and travellers on land could not determine direction. The only thing it gave was means to determine direction in cloudy weather; for by night and day from remote ages direction was determined with fair accuracy by a glance at sun moon or star and closely by astrolabes from 350 B C or earlier. But there is nothing of this in the histories: Marco Polo who tells so much and tells it so well crossed the continent of Asia and rounded it by sea in returning gives only a few times and in general terms the direction they were proceeding in, and no syllable to show how it was found: determination of azimuth was perhaps deemed so simple and universal as not to be worth mentioning and we must conclude for ourselves how it was done. Marco may have carried in his pocket both an astrolabe and compass.

The treatises of Sabokt and Hhassan are like in the solutions offered, and we may suppose the scientific knowledge of Sabokt was equal to that of the latter: to find the hour during day or night both say a celestial body is to be observed through the peep-sights of the astrolabe and then the lines and curves, the *spider's-web* as these were called by the Greeks,[5] gave the angle between the celestial meridian of the observer and a circle through the pole and the body observed; this is called the hour-angle and is the hour. This constitutes determination of an angle of the *astronomical triangle*, the triangle in the heavens at whose angles are the prolongation of the pole of the earth, the zenith of the observer, and a heavenly body. Since Sabokt could determine the hour-angle in this triangle he could determine the azimuth angle which set off on the horizon north or south of the celestial body gives the north or south point. The north except in cloudy weather could be fixed in a fraction of a minute, and this onboard a ship at sea by 350 B C or earlier.

[4] It is first mentioned in ships in about Hhassan's day; below p 265.

[5] The word is Greek; *arachne* in both Greek and Latin. Latin dictionaries give its meaning, "A spider; a Lydian maiden who challenged Minerva to a trial of skill in spinning and was changed to a spider as a punishment; a clock."

The steps necessary to determine direction in a ship at sea by day or night in clear weather are described in 650 A D the instrument to be used being an astrolabe. As regards the antiquity of this we have to observe the treatise of Sabokt is of Greek origin for the Latin author Vitruvius writing in 25 B C describes the astrolabe and states it was invented by the Greeks 200 or 300 years earlier: [6] the dial of Ahaz which stood in Jerusalem in 875 B C was a monster astrolabe.[7] Those who set it in place must have known the relation between azimuth-angle of the sun and the profile on the ground of the "steps" by which the hour of the day was read; which steps though the area covered was perhaps the city plaza were curves of the form of those on the astrolabes observers held on the thumb. Only one conclusion may be drawn; the points of the horizon could be determined in clear weather in pre-historic day.

THE SPIDER'S WEB ON ASTROLABES.

The lines on astrolabes seem to us intolerably complicated but by them an azimuth hour-angle or other quantity could be found more quickly than by our way, though less accurately. Calculating would have been exceedingly slow in Hhassan's day; for our way of ciphering the Arabic had been brought to Europe only 100 years before and was still unfamiliar; while logarithms by which multiplying and dividing are changed to adding and subtracting, a wonderful simplification in calculating with numbers representing angles, were unknown until about 1620. The ancients were without many short-cuts we employ and were very skilful in graphical processes.[8]

The history of the astrolabe the most useful and long-lived of instruments has been told in these words; "The planispheric astrolabe invented of old by the Greeks was a portable instrument permitting the finding of the hour without the solid sphere. x x x It was invented probably by Apollonius of Pergamos about 200 B C. The instrument preserved by the Byzantines was not seriously modified by the Arabs. It re-appeared in the Latin West soon after the day of Gerbert: Hermannus Contractus devoted

[6] See just above as to Sabokt's treatise and just below as to Vitruvius.

[7] Above p 57.

[8] Apollonius of Pergamos 200 B C left solutions by geometry and graphic processes of the theorems stated and proved in modern works on Conic Sections by algebraic formulas: see article Apollonius in La Grande Ency. It has been said that Newton demonstrated his discoveries of the motions of the heavenly bodies by geometry alone, distrusting his earlier discovery of Fluxions; the Calculus.

to it a treatise."[9] This view of the age of the astrolabe comes probably from the book of Vitruvius wherein is found also the oldest description of a ship's log:[1] he wrote, "The astronomer Eudoxus invented the *arachne* others say Apollonius. There are also some who make portable *horologiums* for those who travel."[2] Vitruvius uses the word arachne and not astrolabium though the last was used in ancient Greece and Rome. The ancients applied the name arachne meaning at first only the lines on astrolabes to that instrument in its entirety and called what we call an astrolabe arachne or astrolabium indifferently.

To summarize: astrolabes and the knowledge necessary to determine and use the lines on them is very old indeed. Data of accessory kind was earlier at hand: the declination of the sun and other heavenly bodies, their angle from the equator had been determined; it was known the height of the pole is the latitude; that latitude can be found by the altitude of the sun when on the meridian by applying declination; that the angle at the pole between the celestial meridian and the circle passing through the pole and the sun is the hour of the day; etc. Unless we reject the evidence we must believe knowledge almost sufficed to fix position by astronomy; only in respect to longitude did facilities fall far below those we have. The theory of longitude was familiar but the instruments and data necessary did not exist; not until modern day were the motions of the heavenly bodies known with the nicety required to predict their positions for longitude determination: until the day of the grand-parents of persons now living longitude could be determined only by courses and runs of ships.

Dead-reckoning the humble hand-maiden of sea-farers is very old. In the Bible prior to other history books and before the first date we have for an instrument of navigation there is evidence of competent sea-going:

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[9] Gerbert was Pope Silvestre II 999–1003; Hermannus Contractus died 1054. The words quoted are p 6 Traite du Quadrant de Maitre Robert Angles Paul Tannery 1897. The author concludes that Angles wrote before 1276: his nationality is unknown but he wrote probably in Montpelier, near the borders of Catalonia. near Barcelona where in his day long strides in the art of sea-faring were taken. Tannery shows how the lines for graphic solutions on Angles' quadrant were computed marked on instrument and used in practice: illustrations are included. Angles gave several tables; among these one of the sun's declination for each day of the year: these are co-temporary with the tables of Alfonso the Wise; above p 239.

[1] Above p 48.

[2] Dix Livres trad Perrault bk 9 ch 9. Eudoxus lived 400 and Apollonius 200 B C. I have written *arachne* which is the word in the Latin eds of Vitruvius; Perrault translates it to *araignee;* both mean a spider's-web a clock; *Horologium* means a clock: Vitruvius seems to use it in the same sense as arachne.

in the Book of Proverbs of about 1000 B C we read, "Three things there are that are too wonderful for me:" one of these being, "The way of a ship in the midst of the sea;" and in the description of the good house-wife, "She is like the merchants'-ships, she bringeth her food from afar."[3] Surely when the words were written ships were crossing the high seas being guided as well as was practicable.

CHAUCER ON THE ASTROLABE.

We go forward 100 years from the time of Hhassan to examine another treatise on the astrolabe. About 1400 the English poet Geoffrey Chaucer wrote such a treatise wherein he states and explains the following problem; "To knowe justly the 4 quarters of the world as est west north and sowth. Put the ring of thine astrolabie upon thy right thumb and turn thy left side against the light of the sun and move thy rewle up and down till the streams of the sun shine through both holes of thy rewle. Look then how many degrees thy rewle is raised from the little cross upon the est line and take there the altitude of thy sun." Then the parts of the astrolabe are to be moved in ways described and the plane of the instrument turned into the horizontal: then follows direction, "Take then thy astrolabie with both hands sadly and slyly and let the sun shine through both holes of thy rewle; and slyly in this shining lay thy astrolabie down on a smooth ground and then will the very line meridional of thy astrolabie lie even sowth and the est line will lie est and the west line west and the north line north so that thou work softly and wisely in laying down: and thus hast thou the 4 quarters of the firmament; and for the more declaration lo here the figure."[4]

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[3] Chaps 30, 18–19; 31, 14.

[4] Treatise on the Astrolabe Addressed to His Son Lowys by Geoffrey Chaucer A D 1391 ed by Rev W W Skeat Early English Text Society extra series no 16, 1872 pp 15, 39: figures of the astrolabe are given. Chaucer inscribes the work, "Bred and mylk for children" and begins with the words, "Litell Lowys my son I have perceived well by certain evidences thy ability to learn sciences touching numbers and proportions xx." As respects the origin of the work the editor says p xxiv preface, "I have to point out the sources whence Chaucer's treatise was devised. Mr Halliwell in a note at the end of his ed of Mandevile's Travels speaks of the original treatise on the astrolabe written in Sanskrit on which he supposes Chaucer's treatise to have been founded. Whether the Latin version used by Chaucer was ultimately derived from a Sanskrit copy or not need not be considered here. The use of the astrolabe was no doubt well known at an early period in India and among the Persians and Arabs xx." Mr Halliwell referred to writes in the Gentleman's Magazine April 1839, "The Treatise on the Astrolabe by Chaucer is a literal translation of a tract on the same subject in the Sanskrit one ms of which is preserved in the library of the East India House. Chaucer may have translated it from an Arabic or a Latin version xx."

Chaucer's astrolabe did not differ in essentials from those of Hhassan Sabokt Apollonius Eudoxus nor from the dial of Ahaz. Thus latitude and direction could be determined by ships long before the Christian Era though we have no statement this was done. The compass did not acquire such form as to make it indispensable before 1200 at which date astrolabes [5] were displaced as direction-measurers though retaining place as angle-measurers, notwithstanding appearance of the superior cross-staff and Davis' back-staff, until quite the year 1700, when instruments of the type now in use came in. A competent authority wrote in 1668 that astrolabes furnished the best means of learning the exact time of day.[6] In other words though by 1668 fairly good clocks existed it was necessary to measure an altitude by an astrolabe, take a time-sight, if the hour was required with exactness.

TIME-KEEPERS.

Clocks came into use as soon as accurate. The French philosopher Biot who died 1733 wrote, "The old indented water-clocks that were regulated by horizontal balances and generally used till the year 1660 are now in no great use being far more imperfect than those which have pendulums. xx xx Galileo's son was the first who applied a pendulum to a clock in 1649." Huyghens this work continues had 2 clocks moved by a spring at sea to determine longitude in 1664. These seem to have been fairly successful [7] and were perhaps the first time-pieces driven by springs and of accuracy carried in ships. The balance-wheel to replace the pendulum had still to come and Huyghens was long in search of the way to apply it.[8]

LATITUDE BY MERIDIAN ALTITUDE.

There is record then that the beginnings of nautical astronomy were received from the Greeks by the Arabs, that the science was in competent condition in the hands of the latter in about 800 A D, and that by 1200 Christian people in Spain France and Italy were again taking up the

[5] Pictures and the history of the astrolabe will be found in Enc Brit 11th ed; see also word *armillary*. P 61 n 9 above is cited a work on astrolabes and p 263 and foll'g below the compass is treated. See above p 62 for Champlain's astrolabe recently found.

[6] Tannery Traité de Maitre Robert Anglés p 6 note, citing Lexicon Mathematicum de Vitali Paris 1668 word *Quadrans geometricus*.

[7] Biot Constr and Prin Uses Math Instr trans Stone 2nd ed pp 309–10; containing many illustr. See Captain Cook p 654 below, as to longitude by chronometer and lunar distance about 1765.

[8] Below p 652; p 649 as to time-keeping generally.

science whose foundation was laid by their Greek fore-fathers. In Spain the tables of Alfonso the Wise were computed and Robert Angles made such tables; in Catalonia not far from where Angles dwelt was born Raymond Lull who wrote regarding astronomy and navigation. These things and others of similar nature were accomplished in Italy Catalonia Spain and Portugal in years 1100 to 1300. Regarding the Great Ocean Voyages in 1450–1500 it is sometimes said that only then did navigators learn to use meridian altitude for latitude, being impelled thereto by the fact that the pole-star, which until then they are stated to have used always for this purpose, passes below the horizon on going south. Eudoxus Apollonius Hipparchus Sabokt say nothing of latitude by meridian altitudes but must have known the process for they solved astronomical problems of great complexity. Aboul Hhassan writes of latitude by this method; his words penned about 1250 might be inserted in a modern work on navigation:[9] this was 200 years before the Portuguese began to go south to the Cape of Good Hope. It is also said that at the date of the Great Voyages astrolabes were fitted for use in ships and for taking observations of meridian altitudes; but both are disproved by old astrolabes in existence and early treatises. Meridian altitude for latitude was understood by seamen before they began their slow advance south to the Cape of Good Hope; that is before 1400 and nothing was added to astrolabes at this date nor did the way of using them change.

THE COMING OF WESTERN SHIPS TO THE FAR EAST.

In the oceans south and east of Asia sailing by monsoon and trade winds the Arabs Phenicians Persians Indians Chinese Javanese and others developed ships charts and sea-faring in all branches in independence, and when Portuguese ships entered these seas in 1498 they found seamen as skilful as their own as is shown by the writings of the Portuguese themselves.[1]

[9] See above p 239: below pp 533–34 for what Barros a contemporary historian wrote of ships going south.

[1] Below pp 343–5: the methods employed now in the East would arouse interest. Captain Pagès of the French navy while making a passage in 1775 on the coast of Arabia in a native vessel wrote, "Our pilot a Moorish Indian had much capacity; he determined quickly the vessel's position by rules different from ours which I could not understand. His command was tranquil and precise and he used charts that he had to conduct the ship xx;" Voy Autour du Monde 1770–1776 Pagès 1782 v 1 p 276. There is also by this author in 3 vs an acct of later voyages; here v 1 p 167 he tells of his voyage from Acapulco to Manila in a Spanish galleon in 1768,—an interesting tale showing how this trade was managed or mis-managed: he says, "Though of only 500 tons she carried besides the ship's company convicts women merchants officers civil and

Before Da Gama came to the East native ships had done all carrying for centuries probably for thousands of years gradually striking out to sea more and more until they came to make the run between China and the head of the Persian Gulf or Red Sea without seeing other land than a sailing-ship of our day would see. Even the great Cape at the south end of Africa was known, for on a map made in Venice in 1458 by Fra Mauro is written in the sea south and west of the south end of Africa, " A ship of India carried by stress of weather 2000 miles to the west and south-west of this Cape." [a] This map is the beginning of precise knowledge of the south end of Africa in the West: Herodotus says Phenician ships rounded it about 600 B C Aristotle alludes to it about 325 B C Marino Sanuto shows it on a map made in 1310 and it is on the Laurentian portolano of 1351: [2] but the map of Mauro is of greater creditability than these; it was drawn 30 years before Dias saw the Cape and 40 years before Da Gama did the same: knowledge of it was brought up the Red Sea and across the Mediterranean to Venice by ships.

When the Portuguese rounded the Cape and reached on the east coast of Africa a river they called the River of Good Signs or River of Mercy 20° S they met Arab ships and sailors, Moors they call them for they were familiar with men of similar appearance and speech in the northwest of Africa. At that time the sea-faring of the West was not less than 4000 years old and that of the East probably older but ships of the 2 regions had never been in each other's presence: [3] eastern and western sailors had

military with a large detachment of clerks. xx x The pilots alone are entrusted with navigating the ship. xx x It was a regulation on board that each person should lay in his own water and stores and eat by himself. The crew were not provided even with a common kettle whilst some individuals had one each for his particular use. As each common sailor on board was allowed a couple of servants to attend him our domestics were more numerous than their masters, and being without order or discipline gave occasion to intolerable uproar: " positions on board were, " Often vested in persons who have not the smallest pretension to the character of a sailor." P 188 same v when near the Philippine Islands Pagès made a passage alone in a native craft and says of this, " Departing from Lawan at sunset we rowed westward along the shore. xx My Indians were excellent rowers and the canoe making good way we proceeded 12 leagues before the dawn of morning: " three to four miles an hour for 12 hours steadily; a most excellent performance and better authenticated than any other statement as to speed of oar-vessels: above pp 93–5 as to speed of ancient vessels.

[a] A translation complete for the words given are a part only is p 417 v 2 Cordier's Yule's M Polo. The map is p 660 v 2 Vincent's Com and Nav of Anc in Ind Ocean and p 661 this v is given a 2d legend on it.

[2] Above p 202 n 6 as to allusion of Aristotle; below p 254 as to map of Sanuto and Laurentian.

[3] There exists however evidence to the contrary; see above pp 5, 30.

met for the Arabs were in Spain and the islands of the Mediterranean, and individual westerners had been east as far as the outer sea-coast of China and returned to tell their story. Of the meeting there is much in Portuguese histories but nothing from Arab sources: as no word is said of differences of the ships it may be presumed they were alike; as to navigating at sea Barros the co-temporary Portuguese historian says eastern seamen were as skilful as those of Portugal.[4]

THE MAP OF FRA MAURO: 1458.

The date of this is important for on it the Cape of Good Hope is drawn and near by is written the legend showing the Cape was known to seamen which has been just quoted. It was drawn in Venice in 1458. Thirty years later that is in 1488 Dias rounded the Cape east-bound but there is no writing to show if he had seen Fra Mauro's map. There exists a note written by Columbus which shows Dias' voyage extended 1400 miles further south than earlier Portuguese voyages on the coast of Africa and then 450 miles north that is beyond the Cape.[5] Dias called the Cape *Cabo das Tormentas* and here he lost his life when his ship foundered with all onboard when in Cabral's fleet. The year after Dias' great voyage the King of Portugal sent Covilham and Payva east by land to learn the route for ships. These had an interview with the King before starting on their perilous journey and received, "A sea-card taken out of a general map of the world." As usual on such occasions there were "Learned doctors" present and the emissaries were informed, "It appeared as though in those seas there had been some knowledge of a passage into our western seas because the said doctors said they had found some memorial of that matter." The emissaries departed and Payva was murdered ere long, while Covilham after travelling far and wide being refused by a king permission to return to his own country spent the remainder of his life abroad and is said to have become rich and powerful. The two shortly after leaving Portugual sent the following message to the King, "The

[4] Three Voy Da Gama Hakl p 138, "Da Gama showed the Moors the great wooden astrolabes which he had" and which he used suspended on a tripod ashore to find latitude, and "others of metal" which he used onboard ship. The Moor was not astonished and showed his instruments and charts: on the return voyage Gama procured Arab pilots at Melinde 4° S who went to Portugal; pp 261, 264, same work. See below pp 343–5 as to instruments used by the Arabs.

[5] See below pp 532–33 and n 4 p 533 for Columbus' note and examination of its authenticity.

ships which sailed down the coast of Africa might be sure of reaching the termination of the continent by persisting in a course to the south, and when they should arrive in the Eastern Ocean their best direction must be to enquire for Sofala and the Island of the Moon." [6] The Island of the Moon is Madagascar and with Sofala as well is on Mauro's map which must have been drawn from information furnishd by ships south on the east coast of Africa. Some of these were Arabian, the same as along the south and east shores of Asia, as well as in the Mediterranean and the Atlantic north and south from Spain. The ships of no other people were so widely extended.

MILITARY OPERATIONS OF THE MAHOMETANS.

Shortly after the death of Mahomet 632 the armies of his successors controlled lands from Spain to beyond the Euphrates and in years not long after trading colonies were established along the east of Africa and south and east of Asia from Madagascar north and east to Canton. The Mahometan fleet nearly over-threw the Roman Empire at Constantinople at the Battle of Phenix off the south shore of Asia Minor in 655 and made attempts on Constantinople about 680, assaulting in 717 with 1800 vessels-of-war and transports: [7] this last great attempt failed as did those before because of the sea-power of Constantinople. In the siege of 717 the Greeks used Greek Fire, the prototype of explosive substances.[8] The Saracens were more successful in the western Mediterranean than in its eastern part. In 711 under Gibel-el-Tarik they crossed into Spain at Gibraltar and from there seized the Balearic Islands Corsica Sardinia Sicily and Crete. Cyprus they had seized in 648 for an advanced base as we would say against Constantinople but this was soon wrested from them. The islands except Cyprus they held for centuries and great were the losses inflicted by Mahometan vessels harboring in them on Christian coasts and ships. The fighting fleets of western Christian nations were broken up and dispersed merchant vessels seized or destroyed and there remained of Mediterranean shipping only that of Constantinople, which protected by its war-fleet throve mightily. Our historian writes of these

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[6] India in 15th Century Hakl p lxxxvi, the authority is stated. The emissaries advise ships shall send ashore and enquire the way; exactly what they did do. Whether the learned doctors had Mauro's map is not known.

[7] Finlay Hist Greece v 2 p 15: see below p 376 as to Battle of Phenix.

[8] Below pp 376–7.

days, "Byzantine commerce filled the whole Mediterranean and legitimated the claim of the Emperor of Constantinople to the title of Autocrat of the Mediterranean Sea."[9] The date is 867 to 1057, the date also for the predominance of Moslem power in Europe. By the latter year the sea-power of the Italian coast cities and Marseilles and Barcelona was becoming great and the reconquest of the islands begun.

ADVANCE OF MAHOMETAN ARMS IN EUROPE WAS FIRST CHECKED BY THE FLEET OF CONSTANTINOPLE: THE MAHOMETAN SEA EMPIRE.

The advance of the Saracens is sometimes stated to have been stopped by Charles Martel at the Battle of Tours in 732; but they had received heavy blows at the hands of the people of Constantinople before, being forced 20 years earlier to abandon attempts to invade Europe through that gateway. During these days Mahometan armies and fleets were advancing in Asia and in consequence of this and the establishment of colonies by the ways of peace Mahometan power was extended over a region wider than that controlled by Rome when her empire was largest. Spread along coasts and in islands widely scattered the Mahometan Sea Empire was the greatest the world had ever seen and excepting that of Spain when she seized the dominions of Portugual in 1580 the greatest of all time. Merely to transact business in a region of so great extent called for numerous ships and efficient methods and that caliphs at Baghdad and Cordova summoned scientific men to improve ways of conducting ships is no cause for wonder. If the men in the ships had left a record we would know more of details but there is nothing of this character: the earliest record written by a seaman is that of Columbus; Dias who preceded him a few years and was the greatest discoverer the world has ever known in the field of oceanography and a daring seaman left not a word of his own. The waters in which Mahometan ships were ever-present extended from 30° W to 160° E from Greenwich, and from 35° N to 35° S. Except the ships of Byzantium in the Mediterranean and those of China India and Java in eastern seas they were alone in this wide region, large parts of which had previously been occupied by the Phenicians their kinsmen.[1] It is doubtful if the pleasant view of their own superiority held by people of the West is justifiable.

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[9] Finlay cited 2nd note preceding v 2 p 10.

[1] Above p 34.

SEA-FIGHTING IN THE FAR EAST IN YEARS 500 TO 1400 A D.

We hear little of fighting at sea in the East and its story is indefinite and broken. There was a pirate empire which flourished from the 7th to the 15th century A D called the Empire of Madjapahit with center in Java.[2] It controlled many near-by islands and flourished by piracy. An authority tells us, " The entire possessions of the empire extended from 97° to 132° east longitude and from latitude 10° S to 15° N." [3] We have account of an expedition undertaken by the ruler of this empire which may represent methods by which piratical empires were nourished: [4] The Emperor calls his principal officers and says to them, " Oh my ministers and officers what do you think on the subject of countries gulfs coasts and peninsulas and islands not yet brought under my domination. Would it not be well for you to go conquer them." They collect 900 ships 3 generals to command and 300000 troops and these go to various lands and return, " The spoils were immense. It was impossible to count all the gold and silver ingots stamped money arms various clothing captives wax x x. These riches were inestimable. The King wished them divided into three parts, one for him another for the officers and the third for the soldiers and the rest of his subjects." In the same period and at a place not far away we have record of other great over-seas expeditions. Marco Polo tells of Java,[5] " This Island is also frequented by a vast amount of shipping and by merchants who buy and sell costly goods from which they reap great profit. Indeed the treasure of this Island is so great as to be past telling. And I can assure you the Great Kaan never could get possession of this Island on account of its great distance and the great expense of an expedition thither." In a note appended by Cordier it appears that Kublai Khan sent several expeditions to conquer Java but they were unsuccessful. Marco has this to say of Japan, also coveted by the Khan, " And I can tell you the quantity of gold they have is endless xx. Cublay the Grand Kaan who now reigneth having heard much of the immense wealth that was in this Island formed a plan to get possession of it: " several expeditions were sent thither and in 1274 a fleet numbering 300 ships and 15000 men;

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[2] Java Campbell v 1 p 57; Hist Java Raffles.

[3] Liste des pays x x x l'empire Madjapahit a sa destruction Dulaurier; Jour As Soc 4th ser 7 1846 p 571. This as well as the Addition in the note below is from a native writing found in Java and translated by Dulaurier.

[4] Dulaurier in Jour As Soc 4th Ser 13 1849: see pp 68–69 above as to piracy of Crete and Carthage.

[5] Cordier's Yule's ed v 2 p 272.

this, "Was defeated near the Island of Tsu-Shima with heavy loss."[6] It was off Tsu-Shima the fleets of Russia and Japan joined combat in our day.

LONG VOYAGES IN EASTERN SEAS.

The voyage of Fa Hian from India to China has been noticed[7] and records exist of other journeys in the East but none include anything of sea interest. When Marco Polo set out from Venice in 1271 with his father and uncle for China they went first to Hormuz at the mouth of the Persian Gulf to take ship and failing in that for some reason unknown crossed the continent of Asia to their destination. In returning in 1292 they sailed in a Chinese ship from Zayton and were about 2 years in reaching the head of the Persian Gulf. Marco mentions many things about ships; he says mariners in the East use their own charts speaking with entire respect of these; tells of the monsoons in a clear and graphic way;[8] of his long voyage in one ship; of water-tight compartments to render ships difficult to sink; of private cabins of ships; of the large number of persons on board; of the draft of water of his ship—20 feet.[9]

THE SIZE AND FITTINGS OF SHIPS IN THE EAST IN MEDIÆVAL DAYS: LAWS REGARDING SHIPS.

Water-tight bulkheads in the East are mentioned by others as well as Marco Polo. Nicolo Conti a Venetian who was in India about 1425 and there saw ships of China wrote, "They build some ships much larger than ours x x with 5 sails and so many masts. The lower part is constructed with triple planks in order to withstand the force of the tempests to which they are much exposed. Some ships are so built in compartments that should one part be shattered the other portion remaining entire may accomplish the voyage."[1] The ships of the Chinese and other eastern nations were larger and more luxurious than those in the West as several travellers have stated.[2] We have no explicit statement that Arab Persian or Indian vessels were larger than those in the Mediterranean; but Chinese

6 Cordier's Yule's M Polo pp 253–5 and note 1 p 260.

7 P 218.

8 Writing of Ceylon he mentions the, "Charts of the mariners in those seas" and, "Charts and documents of experienced mariners who navigate those seas"; Cordier's Yule's Marco Polo v 2 pp 312, 424. See above p 210 for his words regarding the monsoons: also p 212 for abstract of the voyage.

9 Marco's words respecting details are above p 212.

1 India in 15th century Hakl p 26.

2 Cordier's Yule's Marco Polo v 2 p 252 note 6.

ships grew larger to carry greater cargoes and more comfortable in fittings to attract merchants and travellers. How long did it take for these ships—the tone of all travellers is one of wonder and admiration, to come to be what they were when we hear of them? Those familiar with eastern languages testify that native writings show intercourse by sea along the eastern and southern seaboard of Asia in the most remote age they reach: we must suppose the time when Chinese vessels, "Crept along the coasts" as the moderns write is very remote. It is not improbable the use of the high seas began in the East.

Probably all who tell of eastern ships had made voyages in those of the West but we read only that the former were built with compartments and very big and comfortable and as points of difference would be mentioned probably the differences stated are all there were. The fluid character of sea-ways is very striking; ships sailors and their ways the laws of the sea even language are broadly alike except where progress in the arts differs widely. Sailors' way of extending betterments over the earth has had however interruptions; Da Gama knew little of eastern ships and seamen though Europeans had been in the East centuries before and returned and written the books we read; and the excellent plan of building ships in separate compartments common in the East by 1200 was not practiced in the West until 1830 when ships were built of iron.

MEASURES ENSURING SAFETY.

Beside bulkheads to confine water to a part of the hull eastern ships had other safe-guards. Ibn Batoutah who was long in China about 1350 wrote, "When a Chinese junk goes on a voyage the Admiral and his secretary go onboard to note the number of archers domestics and sailors. Only when this is done may the ship sail. When the junk returns to China the same persons go onboard and compare the persons onboard. If any one is missing the captain is responsible." [3] As respects overloading rules are also very old but I have been unable to find mention of this in the East. It occurs in the laws of Iceland about the date to which we have come; one reads, "The vessel is sufficiently loaded if when she is divided into 5 parts 3 are under-water and 2 above-water. The measurement should be taken at the middle of the ship." [4] Beside this law in Iceland a place of

[3] Ibn-Batoutah trad Defremery et Sanguinetti v 4 p 264: same v p 269, "The port of Zayton (now Chinchew the terminus of western trade in mediæval days) is one of the greatest in the world. I am wrong it is the greatest of all ports. I have seen there about 100 large junks, as to small ones they are innumerable."

[4] Pardessus Coll etc 6 vs p 64 v 3.

great interest in the history of sea-faring laws of similar import may be found by the index of Pardessus' work; word *surcharge de navire.* The Code of Manou drawn up in India and believed to have been in its present form before the Christian era lays down prices to be charged for passages on rivers and prescribes, "As on the sea the speed of the vessel depends on the wind x x x there is no means of knowing the various prices of passage."[5] By this law it is shown ships at sea relied on sails.

The Code of Malacca of the date of Marco Polo consists for the most part of prescriptions of punishments for violation of rules and includes this law throwing light on ways in ships,[6] "The captain becomes King when he is at sea and even if he should be young should be considered an old man as long as he is at the head of the vessel." This is still law.

THE GEOGRAPHER EDRISI.

Edrisi was an Arab who dwelt in Sicily under protection of Roger II a Norman prince whose father Roger I son of Tancred came to Sicily with a fleet and drove the Saracens out and made himself King about 1060 A D. The Geography was written when the Crusades began, full 100 years after the Northmen countrymen of Roger crossed the sea to Greenland and America, yet although Roger sent to Scandinavia for information for Edrisi his Geography does not mention these voyages. He says little of China which he calls *Sin* except that its trade is very great and that Khanfu probably Canton was a great port and terminus of trade from the West.[7] He calls the Atlantic the Sea of Darkness; writing, "The first climate commences at the west at the western sea that is called the Sea of Darkness. It is that beyond which no one knows what exists. There are in this sea two islands called Al-Khalidat from whence Ptolemy begins his latitudes and longitudes." He mentions the light-house at Alexandria whereon is, "A fire to serve as a signal." "No one knows what exists beyond the Sea of Darkness," he goes on, "Because of the difficulties which are opposed to navigators by the deepness of the darkness the height of the waves the frequency of tempests the multiplication of monstrous animals. x x x There are however in this ocean a great number of islands."

Ships from various places in Europe and Africa and from Phenicia

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5 Pardessus v 6 p 387.

6 Pardessus v 6 pp 385, 392; same v pp 406 rules as to pilots; 412 as to privacy of cabins in ships; 420 as to consultations of all onboard captain must hold; 423 consultations when the monsoon changes; etc.

7 Yule Cathay 2 vs p cxiii v 1.

had visited the islands 1500 years before Edrisi's day and though his book shows he knew this his recital of the terrors of the Sea is often referred to as showing a limited ocean navigation. Edrisi tells the story of a remarkable voyage; the Lisbon Wanderers he says went forth into the Sea of Darkness provided with water and food for several months sailing with the first of an east wind. They proceeded 11 days and then 12 more south and landed on an uninhabited island then south 12 more and landed on another island. Here they were attacked by natives and made prisoners and told they were 2 months' journey from home.[8] The ships steered south 35 days in all and the crew when landed in Africa were told they were 60 days' journey from home. The so-called islands may have been the continent of Africa. If the ships followed the coast of the continent for 35 days making good 50 knots a day they did not quite reach Sierra Leone: Mommsen says Phenician ships were trading here 2000 years before.[9] The ships ran in all probably about 3500 miles and were 1500 miles by land from the Strait of Gibraltar; the men would have to walk or ride on animals 25 miles a day to arrive in 60 days. The story does not work out badly; it is certainly the record of a long sea-voyage, probably one of many in the day.

The Geography of Edrisi confused and unsatisfactory as it is is the first European writing in which China is called by that name albeit written *Sin;* and what is told of the Lisbon Wanderers though a satisfactory track-chart cannot be made yet foreshadows the progress of knowledge south from Gibraltar which was to lead to Marino Sanuto drawing a map about 1310 showing the south end of Africa, whereon he mistakenly wrote, "Region uninhabitable because of the heat;"[1] to the Laurentian portolano of 1350 showing Africa in true form and the islands west in the Atlantic;[2] and to the voyages south which ended by rounding the Cape by Dias in 1487. As we read of the discovery of the Western World it seems simple; Columbus discovered America in 1492 Da Gama went to India 1497 Magellan sailed around the world in 1520; but on trying to discover how this was done we enter on uncertainties very fascinating because

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[8] Edrisi Desc de l'Afrique etc trad Dozy et Goeje 1866 pp 1, 166, 197, 223. There is also Geog Edrisi trad Jaubert 1836 2 vs. Beazley comments on Edrisi at length in Dawn Mod Geog; see words Edrisi and Wanderers in his index.

[9] Above p 34.

[1] Major Prince Henry ed 1868 pp 106–7: the map is p 51 Nordenskiold Periplus and p 521 v 3 Beazley Dawn Mod Geog.

[2] The map is p 439 v Beazley cited note next above.

though not always understandable, the narrative is faithful and exhibits courage enthusiasm and devotion unsurpassed: Leonidas and his men in the Pass of Thermopylæ or the Imperial Guard of the great Napoleon are not more stirring. The late Mr Major one of the most learned geographers of his day wrote of the two maps alluded to, "Far more startling than the map of Sanuto is a map in a portolano of the year 1351 in the Laurentian library in Florence x x."[3] He means of course because it shows the Cape though drawn 150 years before Dias was there.

BENJAMIN OF TUDELA.

Closely after Edrisi comes Benjamin of Tudela a Spanish Jew who travelled 1159–1173 reaching India which he calls *Khandy*, and possibly China which he calls *Tsin*. He is the only European who encountered successfully the perils of the journey to the East before the Crusades in some degree abated danger from the Saracens and the pioneer of the intrepid men of great physical strength and endurance who continued to go to Asia by land until the Portuguese found the way by sea. Being in Ceylon Benjamin wrote,[4] "From hence the passage to Tsin is effected in 40 days." The shortest route by sea from Ceylon to China is 3500 miles, so daily runs of 88 miles made good on the course were made; under ordinary circumstances of wind and weather ships would have to log 120 to 150 miles per day to do this but since they sail here with the monsoon 100 might be taken as the necessary performance.

ODORIC OF PORDENONE AND IBN-BATOUTAH.

Odoric was a priest of the Roman Church born at Pordenone near Venice 1286 and died 1331. He set out about 1315 and returned 1330 having been in India and China.[5] Odoric and Batoutah

[3] Work cited note 2d above p 107. See pp 202 n 6 and 258 as to the earliest traces of knowledge of the S point of Africa.

[4] Early Trav Palestine Bohn 1848 pp 116–17; Yule Cathay 2 vs p cxlv v 1: the words quoted are followed by others of fabulous character.

[5] Yule Cathay 2 vs pp 43–162. There is much of interest in Odoric's book translated by Yule: see for example pp 44, 57, 73, 84, 90 (here Odoric states hearsay reports of the Moluccas first visited by Portuguese ships going east 225 years later and a few years afterward by Magellan going west), 103 (here he writes he started from India and, "Sailed eastward over the Ocean Sea for many days and came to that noble province Manzi xx. The first city I came to in this country is called Censcalan [Canton] and 'tis a city as big as three Venices. xx And this city hath shipping so great and vast in amount that to some it would seem well-nigh incredible. Indeed all Italy hath not the amount of craft that this one city hath"), 124, 217.

were nearly contemporary; the former dying in 1331 and the latter returning home in 1355 after wandering in foreign lands for 30 years.

Batoutah also was in China and he and Odoric give runs of ships they sailed in at from 50 to 100 miles made good per day with the length of time at sea from 10 to 100 days. Some of these runs are in the Mediterranean or Black Sea but most in waters south and east of Asia. As only the days from one port to the next is given, the speeds are figured on the distances between ports measured on a modern chart: to a distance so measured about ½ should be added to estimate distance sailed and thus the ships logged 75 to 150 miles in twenty-four hours. Our authors write occasionally in a way to arouse the envy of travellers by modern liners: "Now onboard that ship," wrote Odoric,—she was Chinese and going to China from India—"There were a good 700 souls what with sailors and merchants." In another place he tells of the ships of Ningpo, "And all the ships are as white as snow being coated with white-wash. And aboard them you find halls and taverns and many other conveniences as handsome and well-ordered as are anywhere to be found. Indeed it is something hard to believe when you hear of or even when you see the vast scale of the shipping of these parts." When leaving Ormuz for Tana near Bombay Odoric writes, "In this country men make use of a kind of ship they call *jase* which is fastened only with stitching of twine. In one of these I embarked and I could find no iron at all therein x x. I passed over in 28 days to Tana."[6] Yule says *jase* is Persian for ship. Evidently ships fastened by iron spikes were familiar to Odoric; they were thus fastened in China, but often stitching only in waters near China.

DETERMINING LATITUDE BY LENGTH OF THE DAY.

Digression may be made to notice an attempt to find latitude by the length of the day by Friar John of Montecorvino in 1300. He was in India in latitude 12° N and wrote,[7] "As regards the length of the day and night I have tried to determine them by such measures and indications as I could. x x x When the sun's rays strike perpendicularly without casting any shadow the day is 15 hours and the night 9. And when the sun is at the solstice of Cancer the day is a little less than 14 hours and the night a little more than 10, perhaps by a quarter of an hour. But when the sun is in the solstice of Capricorn that is to say in the month of Decem-

[6] Yule Cathay 2 vs pp 73, 124, 57.
[7] Yule cited note next above v 1 pp 210–11.

ber the day has a length of 11 hours and the night of 13. x x Moreover the star we call the pole-star is there so depressed it can hardly be seen. And methought if I had been on a lofty point I could have seen the other pole-star which is in the opposite quarter. I looked many a time for a sight of it and I saw several constellations which move about it; from observing which I gathered that they were exceedingly near to it." The Friar's words do not bear critical examination and are given not to exhibit a faulty astronomy but to bring to mind the necessity for and probably existence of time-measurers; gnomons clepsydras and sand-glasses, perhaps mechanical clocks. By the date finding latitude by the pole-star and meridian-altitude of the sun or other celestial body had long been known.[8] The question how the Friar made sure his instrument was going correctly is interesting. If he had a clepsydra or sand-glass already set and to be relied on we can appreciate what he was doing; if he had a mechanical clock and he may have had one though hardly of portable character we can understand also; if he used a gnomon or astrolabe of which the lines had been computed for the Mediterranean it was inaccurate because his latitude was 25° lower than that of the Mediterranean. It is difficult to see how elapsed time could have been determined in any way but by a sand-glass or clepsydra unless a long time was occupied in preparing for a determination of astronomical character.

IBN-BATOUTAH AGAIN.

Batoutah passed through Alexandria in 1325 on the way to China and saw the famous light-house and says of it on his return in 1348, "I found that its ruin was complete, Almelic undertook to construct a similar tower just opposite but death prevented him."[9] He tells that onboard the ship he took in India for China, "Were 70 horses a part of the gift of the King of India to the Emperor of China. x x x There was provided water food and forage." Further on he writes, "We went to Kalikouth (Calicut) one of the great ports of Malabar. The people of China Java Ceylon the Maldives Yaman and Fars come here and traders from many places are united here. Its port is among the greatest in the world. We entered the port with much pomp such as I have never seen in this country.

[8] See above p 53 for other determinations of latitude by the length of the day; below p 651 n 1 for its inherent inaccuracy.

[9] Ibn Batoutah ed cited v 1 p 29: also Yule's Cathay 2 vs, v 2 p 397; pp 483, 486, 510, 514, for other matter of interest, and pp 411 and 415 for an embassy sent from India to China by sea.

x x x There were there then 13 Chinese ships. x x x No one traffics in the Sea of China but in Chinese vessels (he states further on however he returned from Zayton to Sumatra in a Sumatran ship). There are three kinds of these, 1st, the great ones which are called *gonouk* and in the singular *gonk;* 2nd, the middling called *zaou;* and 3rd, the small ones called *cacam.* There are in one of these large vessels 12 sails or fewer to 3. x x x Each ship is manned by 1000 men, namely 600 seamen and 400 soldiers. x x They are built only in the city of Zayton or Canton. This is how they are made. x x x Each ship has four decks; they comprise rooms cabins and saloons for the merchants. Many of the cabins contain numerous conveniences. They have keys and those who occupy them may lock them. They take with them their wives and concubines. It happens often that an individual is onboard and no one knows he is there until the ship arrives. The seamen have rooms for their children they plant herbs and vegetables. x x x The captain is a great man; when he goes ashore the archers and soldiers march before him with instruments of music. x x x In China there are many merchants who own numerous ships. x x x There is not in the universe people so rich as the Chinese." Then the narrative goes on about securing accommodation by ship; it reads like a family party's arrangements from New York to Liverpool.[1] Batoutah tells of a ship on the rocks and a young woman who throws herself overboard to reach the shore but is drowning; " A seaman from Ormuz " swims out and saves her and is offered by a rich man some pieces of money but refuses them, " I did it only for the love of God," [2] he said.

EARLY NOTICE OF MAGELLAN CLOUDS AND OTHER INDICATIONS OF VOYAGING IN THE SOUTH.

An early record of Magellan Clouds has been preserved by a cotemporary of Marco Polo: a certain Peter physician and astrologer an Italian born 1250 wrote,[3] " In the country of the Zingi [4] there is seen a star as big as a sack. I know a man who saw it and he told me it had a

[1] The passages quoted are in ed cited note next preceding v 4 pp 55, 88. Dampier whose date is 1680 describes Chinese ships much as Batoutah and Marco Polo; see below p 667.

[2] V 4 p 96. There are voyages given which may be constructed; they all lead to the conclusion that ships were at sea for long periods and made good at times full 100 miles per day.

[3] Yule's Cathay 2 vs p 324 v 2.

[4] Yule identifies this as near Java.

faint light like a piece of cloud and is always in the south. I was told of this and other matters by Marco the Venetian the most extensive traveller and most diligent inquirer I have ever known. He saw this same star under the Antarctic; he described it as having a great tail and drew a figure of it *thus*.[5] He also told me that he saw the Antarctic Pole at an altitude above the earth apparently equal to a soldier's lance whilst the Arctic Pole was as much depressed." It is not certain whether this means Magellan Clouds the Southern Cross or both these, for Marco must have seen both, and all voyagers in southern latitudes notice them: Pigafetta who was with Magellan, after leaving the Strait and being well out in the Pacific writes,[6] "We discovered to the west five very brilliant stars placed exactly in the form of a cross." This must have been the Southern Cross though Pigafetta says it was in the west. A knowledge of this great constellation was in Europe at a time when many believe the southern hemisphere a *terra incognita:* Dante wrote, probably before 1300 for he died in 1321, "I turned me x x to the other pole and beheld four stars never yet seen save by the folk of old time."[7] Portuguese navigators as late as 1580 occupied themselves with getting latitude by the Southern Cross. The cross stars in the Cross are 30° from the pole; the stars we call Pointers by which are found the north star are the same distance from the north pole. The rules for finding latitude by the Southern Cross would be of the same character as those for the north pole-star. Portuguese treatises on latitude by the Southern Cross were called *Regimento da altura pollo Cruziero do sul* and will be found pp 147–8 Bensaude Astronomie Nautique au Portugual 1912.

There is in the records of these days another allusion to Magellan Clouds. Pedro Sarmento de Gamboa sailed from Callao in 1549 bound through the Strait to Spain. When in the South Atlantic he writes, "This evening there appeared a shooting star as large as a scepter and broken into bits. It came from about E S E and went to W N W; the color was blue and white. It was in the first watch.[8] It denoted wind from that quarter and thus it came at dawn." The work from which this is

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[5] A figure is shown by Yule; presumably from the writings of Peter, printed 1521.

[6] Premier Voy autour du Monde Amoretti p 55; see Guillemard's Magellan p 256 where notice of Magellan Clouds earlier than the day of Marco are stated.

[7] Purgatory Butler's prose trans canto 1 line 23 p 3. In about the day of Dante the Southern Cross ceased to be visible at Alexandria in Egypt: it now crosses the meridian there 3° below the horizon.

[8] The Spanish is *prima noche*. Throughout all time on sea and land the night has been divided into three watches.

quoted has a picture of a Magellan Cloud drawn by Sarmiento and views drawn by him of head-lands sighted.[9]

CHARTS.

Charts were used in pre-historic days and are readily made by people in very primitive state of civilization; but there exists no mention by a chronicler of events of his own day of a chart in use in a ship until 1270 A D.[1] There is in Herodotus an account of a survey made over water by ships for the purpose of making a chart for the fleet of Darius King of Persia 521–485 B C,[2] and there exists a map made near the Persian Gulf before 3000 B C.[3] Also there are descriptions of how maps were made in early days; one made by Abram about 2000 B C, one by Joshua about 500 years afterwards, and one made about 600 B C for use in besieging a city; all of which are described sufficiently in detail to enable one to understand how the data necessary to draw them was obtained.[4] The map of Joshua was for military purpose and it was made as armies now make field-surveys: the only difference between what Joshua's servants did and what the engineer party of a modern army would do is this; the former measured distances by counting their steps while walking or counting the steps of their horse, the last would be saved the trouble of counting by a pedometer, a counting-machine hung on the person while walking or riding along selected compass-courses. Angles were measured of old as we measure them, by plane-tables or similar device; but the ways of computing with angles are simpler now than formerly.[5] The survey made over water for Darius was made in the same way; distances sailed by ships—where the crews could not land—replacing distances walked or ridden over land. The ships were kept on a course as a walker on land would be by angle from the sun or a star, perhaps with an astrolabe, and distances determined by the elapsed time sailed on a course, noting time with a clepsydra or hour-glass, or perhaps distance sailed was

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[9] Viage al Estr de Magal por el Cap de Gamboa Madrid 1768 p 301. There is an Eng trans in Hakl.

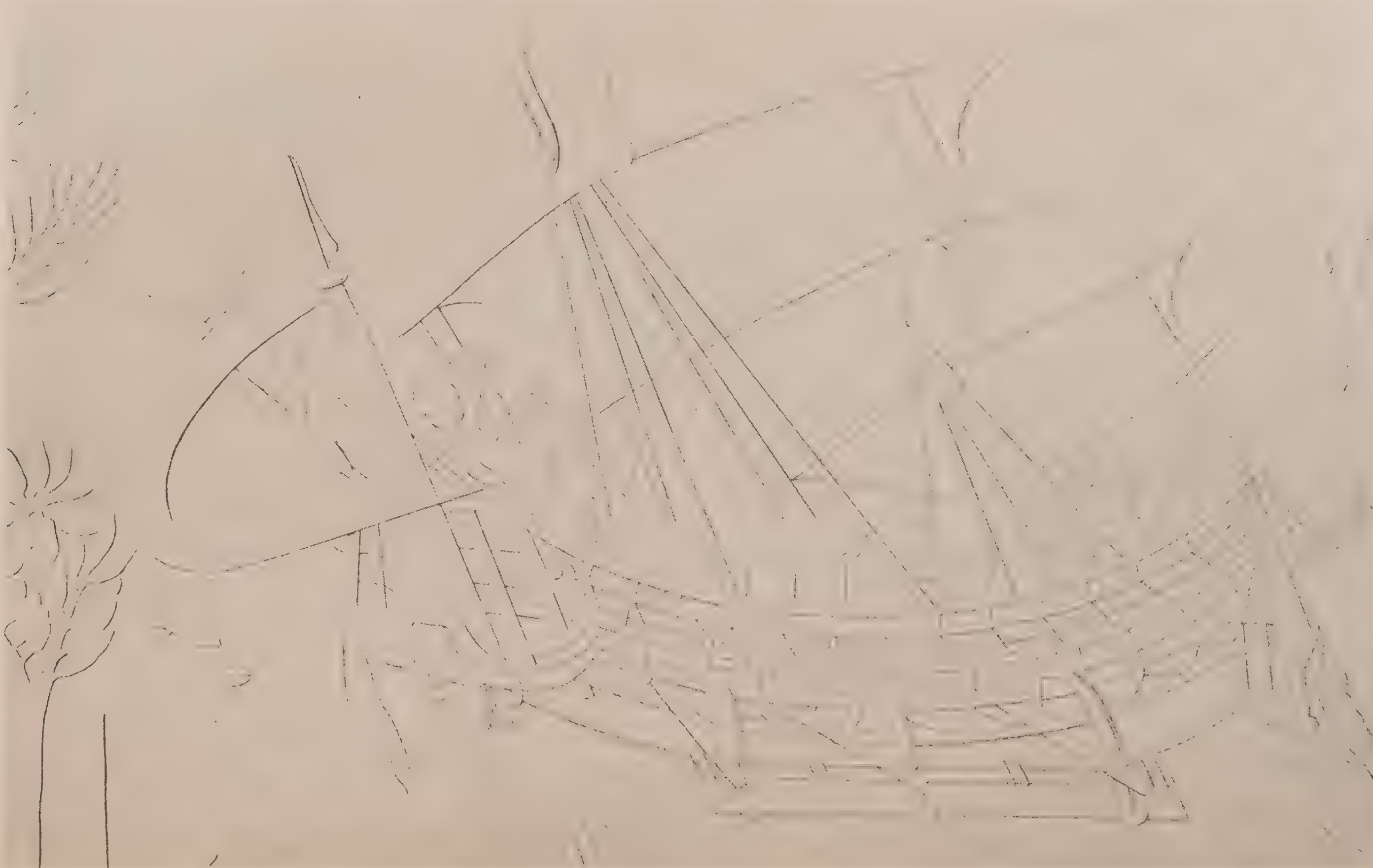
[1] Below pp 428–9: pp 297, 302, is acct of sea-charts made in Europe 1300 and 1375 A D, and p 21 above of them in China about 1400 A D.

[2] Above p 22.

[3] Above p 21.

[4] Above p 21.

[5] Egyptian house-builders when they appear in history were using a rule still used: that a triangle whose sides are 3, 4, 5, long gives a right angle.



Eastern craft shown in carvings at Boro-Boudour in Java; being pl 101 in work identified n 9 p 261. No way of steering appears unless the man at the stern clinging to a spar has something to do with this: at least two women are shown in the ship.

noted directly by an appliance like the log described long after by Vitruvius and by him ascribed to the ancients.[6]

SHIPS AND SAILORS.

Of the ships in seas between Arabia and India in early days we have no account but they often met ships of Egypt in the Red Sea and coast of Africa and it may be assumed they were alike. Of Egyptian ships more is known than of those used in Phenicia or Greece many years later for we have representations of the former on stone and only written descriptions of those of Greece and scholars are not in agreement as to the meaning of these. We would wish to know whence came the sailors in these vessels. Those of Egypt were probably manned in large part from that country; but there is reason to believe ships in the East had many Arabian sailors. Colonel Yule who has given much attention to early history of the East and necessarily to sea-faring there is of this view,[7] basing his opinion on the fact that voyagers in the East of widely separated dates and in different places tell the same tales; the forecastle yarns of wandering Arab seamen he thinks. No travellers of early day and their number was prodigious but knew the sea; there were few roads the land was uncleared and robbery on land more likely than at sea for all ships went armed. When we read the records of Benjamin of Tudela and Odoric who were in the East in 1170 and 1300 and of Marco Polo it must be remembered there were many Europeans in the East in their day; in books of travel we read of the doings or habits of Christians Saracens and idolaters, signifying our chroniclers were not alone.

THE PICTURES OF SHIPS CARVED ON THE TEMPLE OF BORO-BOUDOUR IN JAVA.

The pictures of early Egyptian ships are alluded to above.[8] They are freighters round-ships and there are pictures of vessels of the same class carved on stone in the Buddhist temple of Boro-Boudour in Java. They are Malay or Javanese their date is that of the temple 8th or 9th century A D and they are thus 3500 years later than those in Egypt.[9]

[6] Above p 49. Even now I believe the referee counts a prize fighter out by measured beat of his arm.

[7] Above p 23.

[8] Pp 26 and foll'g.

[9] See Boro-Boudour dans l'Isle de Java Wilsen and Brummund, prepared by order of the Government of Holland and printed 1874. There are many plates, 12 of ships, the text is in Dutch and French. Pp 536 and 537 of the French text state the temple was built in the 8th or 9th century.

The most interesting of the plates are nos 101 and 103 wherein the ships are sea-going.[1] Each has two masts one sail on each and like early ships of Egypt there is a yard at both head and foot of the sail; there is an outrigger to windward; no means of steering shows; there is an inclined mast projecting at the bow with a sail on it. There are objects which may be compasses to steer by. The editors of the book express this view and it seems the most reasonable conclusion. These are small circular objects drawn in the vertical plane, perhaps so they may show, for compasses would be horizontal. They are situated on projections at the bow and stern; men watching are by them; the one at the stern has his arm and finger stretched out over the circle. This man faces aft with back towards a figure which is the pilot; the pilot faces forward and has an arm outstretched. The man watching the after circle cannot be steering the ship; his situation and appearance forbid this conclusion; but that he is *conning* her—directing a steersman how to put the helm—seems probable. The Middle Ages were passed before compasses were placed before steersmen; the clumsy plan of a pilot with a compass before him directing how the helm was to be put was universal.

These pictures were made about 800 A D. Klaproth our principal authority on the compass cites a Chinese dictionary of 121 A D in which the word magnet is defined, " Name of a stone with which one can give directions to a needle: "[2] In a translation from the Chinese of the voyage of Hwui-Shan is written, " A D 543 Pe-tsi sent a valuable apparatus which pointed to the south."[3] If we accept existing evidence we must expect to find compasses in Malay and Javanese ships of 800 A D.

TWO PICTURES OF MEDIÆVAL CHINESE SHIPS; CHARTS SUCH AS THEY MAY HAVE CARRIED.

There exists a picture of a Chinese ship of about 1400 A D 600 years after those at Boro-Boudour and copies of charts such as she may have carried.[4] We have charts made in Europe earlier than 1400 and these have usually ships drawn on them. The custom of thus decorating charts

[1] A wood-cut will be found p 247 v 2 Cordier's Yule's Marco Polo; it is too small to show an interesting detail mentioned immediately below: see picture here inserted.

[2] Boussole p 66: see just below as to compass.

[3] P 623 An Inglorious Columbus or Evidence Hwui-Shan x x Disc Amer in 5th Century Vining 1885. A glance at a map shows this can easily be done in extreme north: see also L'Amerique sous le Nom de Fou-Sang and Nouvelles Preuves que Fou-Sang est L'Amerique, both by Paravey.

[4] Above p 21; also p 214 for a Chinese wall map on silk of the year 265 A D whose scale is 1 inch = 30 miles. See also the 5-masted Chinese ship on the Catalan map of 1375; p 21 n 4.

lasted until 1700 and ships drawn near the later time are very informing while those of earlier days are poor; almost grotesque. By 1400 Chinese ships must have long carried compasses for we have a sailor song of the day running as follows; [5]

"With Kunlun to starboard and larboard the Cheu,
Keep conning your compass whatever you do,
Or to Davy Jones' locker go vessel and crew."

THE COMPASS.

If the objects in the ships at Boro-Boudour are compasses they are the first of which we have record in ships, of date 800 A D. It is impossible to state the steps by which the compass reached its present form. In Klaproth's Boussole statements of Chinese works ascribing great antiquity to knowledge of the directive power of a magnetized needle will be found; Biot a French savant also puts this knowledge back very far; [6] and Professor Hirth is of the same view. Very possibly the polarity of a magnetized needle was first used as a play-thing and it appears compasses were used in China in wagons earlier than in ships. Klaproth gives a figure of a wagon with compass quoting Chinese works which ascribe to them a fabulous antiquity and states they were employed by an emperor who reigned 806 to 820 A D.[7] The conclusion is that although we cannot discover the steps in the development of the compass we must believe it was noted many years ago that a magnet turned north and south; but we can no more find when and how this was first noticed than find the highest rill that goes to make the Mississippi River.

A good reason for believing ships carried compasses before the date usually stated, 1100 to 1200 A D, is that travellers between 900 and 1400 A D whose stories we have, Masoudi Khurdadbeh Batoutah Odoric Marco Polo and others, all of whom were in ships, do not mention the compass. These men cover the period when the compass is said to have been first employed in the West lapping over both beginning and ending but say not

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[5] Above p 21 n 5.

[6] See Comptes Rendus Acad Sciences t 19 July-Dec 1844 p 824; where quoting early works Biot says, "These two passages x x denote the knowledge of the compass or magnetized needle in China at least from the first century before our era." He adds that in years 265 to 419 A D there were ships in which compasses were used: see as to the last Klaproth Boussole p 67.

[7] Boussole pp 74–90; it is not without interest to note that the wagons with compasses were fitted also with a mechanism attached to the wheels which sounded by a little drum how far the wagon had proceeded;—a log like that of Vitruvius.

a word about them. They help us not at all except to make us inclined to believe compasses were used by ships in days earlier than theirs; for they cannot have come in later day and if in their day gossips as intelligent and all-seeing would have alluded to them.

ONLY THE POLARITY OF THE MAGNET INTERESTS US.

That natural magnets attracted or repelled certain substances and amber and other materials when rubbed had the same property was known in the Mediterranean world in pre-historic times. Our interest is only with the property of polarity and we do not know when or where it was first noticed that a free magnet turns north and south. Fa Hian being in a ship near Java about 500 A D says in cloudy weather she could not tell direction and followed the wind; [8] and to show the compass was not at this time known in the West, Claudinus of about 400 A D wrote of, "The stone called *magnes*, dark black of little value;" and Raban Maur Bishop of Mayence who died 850 in a work called De Universo refers to the magnes, lodestone, among remarkable stones but does not mention its polarity. Klaproth refers to Claudinus and Beazley to Raban Maur [9] both expressing the view that neither knew the directive power of the magnet.

The objects on the ships at Boro-Boudour may not be compasses although we hear of them in China long before their date. Klaproth gives 121 A D as date of a Chinese dictionary defining the word magnet as a stone which will give power of direction to a needle. On Klaproth's next page is a quotation from a Chinese work saying that between 265 and 418 A D, " There were already vessels which were directed to the south by the magnet; " further on he writes, " Nevertheless the most ancient description of the compass I have been able until now to find in their books dates only from 1111 to 1117 A D." [1] Klaproth does not state his conclusions and while there have been many commentators on the compass none has gone beyond him in explicitness of statement.

In Hirth's Ancient History of China we read, " The reign of Ch'ong-wang 1115–1079 B C has been quoted by Chinese and foreign authors alike as the period during which the north or as the Chinese say the south-pointing qualities of the magnetized needle were discovered x x. During the Tsin dynasty 265–420 A D there was also a *chi-nan-chou, i e,* ' A

[8] Above p 218.

[9] Boussole p 7; Dawn Mod Geog v 3 p 508 note; see also Nordenskiold Periplus p 49.

[1] The first quotation is given above p 262 the 2d is p 67 Boussole and the 3d p 95 Boussole.

south-pointing ship.' " Of about 1107 Hirth says, " From other sources it may be shown that at this time the magnetized needle must have been well known if not as a guide to mariners at least as an instrument in the hands of geomancers for centuries before that date." There follows in Prof Hirth's work this interesting statement, " If my assumption proves correct that the magnetized needle was seen by Arab traders on the coast of China in the hands of geomancers was applied by them to navigation and was then brought back to China as the mariner's compass the history of this invention may be looked upon as perfectly analogous to that of gunpowder, the preparation of which was probably known to the Chinese long before they learned its application to fire-arms through Europeans:" Hirth adds, " The variation of the needle was well known about 1115 A D." [2]

The compass has come to be what it is by undiscoverable paths. It was used many centuries ago in the East and first in Europe about 1100 to 1200 A D, consisting of a magnetized needle carried in a cup of water by a float; at which epoch a *light was attached* to the cup so direction could be seen at night. A few years later the needle was mounted on a frictionless bearing.[x] Few will be prepared to read the following description of compasses by the doctor of a ship wrecked in Korea in 1653; " The compasses are of different form from ours xx. They use a little piece of wood pointed in front and obtuse at the other end which they throw in a cup of water. Its pointed end turns to the north. It has a magnet within. They name only eight winds." The great English seaman Frobisher writing about 1590 thought enough of water-compasses to describe them.[3]

A COMPASS IN A SHIP IN STRAIT OF MALACCA IN 1090; IN ONE ON THE COAST OF SYRIA IN 1242; IN ONE IN THE FLEET OF WILLIAM THE CONQUEROR IN 1066; AND SIMILAR CASES.

Hirth gives a passage [4] concerning the use of a compass in a Chinese ship trading between Canton and San-fo-tsi (In Strait of Malacca) in about 1090; it is from a Chinese work and reads, " In clear weather the captain ascertains his position by looking at the stars in the day-time

[2] Columbus is believed the first Westerner to notice compass-variation. The quotations given are in Hirth's Anc Hist China 1908 pp 126, 130, 131, 134; see also Biot cited n 6 p 263 above. Libri Hist Sciences Math v 2 p 62 note gives evidence showing the first mention of the compass in European literature may be held to be within narrow limits,—1117 to 1130.

x Below pp 269 and foll'g.

[3] Klaproth Boussole p 137 for compass in Korea; below p 351 n 8 as to Frobisher.

[4] Work cited note 3d above p 133.

by looking at the sun, in dark weather he looks at the south-pointing needle (chi-nan-chon). Sometimes he will make use of a rope 10 *chang* in length to bring up mud from the bottom of the sea the smell of which will tell him where to go." [5] This precedes by 100 years the writing of Guyot de Provins to which we come presently, the first mention of a compass in European literature. An Arab Bailak Al Kibdjack wrote about 1242,[6] "Captains who navigate the Sea of Syria when the night is so obscure they cannot see any stars x x take a glass filled with water placing it in the interior of the ship away from the wind. Then they take a needle that they place in a piece of wood formed like a cross. This they cast in the water and it swims. Then they take a magnet-stone as large as the palm of the hand or smaller. They approach this to the surface of the water impressing a movement of rotation to the right so that the needle turns on the water; then they remove their hand suddenly and without fail the needle points its ends to the north and south. I have seen it do that with my eyes during a voyage at sea from Tripoli of Syria to Alexandria in the year 1242. It is said that captains in the Sea of India replace the needle and piece of wood by a sort of a fish of thin iron hollow and disposed so that when thrown on the water it swims and designates by its head and tail the north and south. The reason the fish floats is that even metallic bodies when hollow and displacing more water than their weight swim on the surface of the water." Master Wace who went to England in 1066 with William the Conqueror wrote, "On the head of the ship in front which the mariners call the prow there was a figure of a child in brass bearing an arrow and a bended bow. His face was turned toward England and thither he looked as though he was about to shoot so that whichever way the ship went he seemed to aim onwards." [7] The figure contained a magnetized needle and if set so the figure pointed to England it would continue to do this as long as the ship remained in the straight line to that country. It is not unlikely that an humble person may have made a living by exhibiting

[5] In the books written by men who at this date were in European Crusading fleets there is no statement as interesting and full. The compass is here clearly alluded to; it is impossible to explain how the captain ascertained position at night by the stars and in the day-time by the sun except by supposing he measured altitudes with an instrument. It may be however he was merely determining direction; using perhaps an instrument and perhaps a practiced judgment. Thus in the Far East in 1090, the year of the First Crusade, we have what may be determination of position by astronomical means.

[6] Klaproth Boussole p 59; Beazley Dawn Mod Geog v 3 p 538 note.

[7] Chron Norm Conq from Roman de Rou trans Taylor p 120.

the figure; we shall see presently that by 1066 philosophers and others in England and France were familiar with the needle's property of pointing to the north and this may well have been known to others at earlier date, to be practiced in ways serious or trifling.

In the Chau-Ju-Kua is written,[8] "Su-King in the narrative of his mission to Korea in 1122 x x describes the use of the, 'South-pointing floating needle,' by a ship in which he sailed from Ning-po as if it were a new invention." This work gives sailing-directions of 790 A D between Canton and the head of the Persian Gulf stating compass courses and distances as modern sailing-directions would, mentions "Ornamented pillars" set up in the Gulf of Persia and carrying lights at night for the guidance of mariners, and gives routes of Arab ships to China.[9]

THE COMPASS IN THE WEST.

The earliest mentions of the compass in European books are in considerable number and nearly at the same time. A Frenchman Guyot de Provins wrote about 1190,[1] "By virtue of the magnet-stone brown and ugly which touches iron x x; then the needle which has been touched is fixed in a float and thrown on the water. Then it turns to the Star and the mariner doubts nothing. When the sky is foggy and obscure so that neither star nor moon can be seen then the needle has a light." The light indicates that compasses had been in use a long time and that it was watched continuously. Next comes Jacques de Vitry a French prelate who upon returning from Holy Land about 1210 wrote his Historia Orientalis in which occurs this, "The magnet is found in India and draws the iron to it. x x x An iron needle after it has touched the stone always turns to the northern star which does not move around the axis of the heavens as do the other stars, whence it is very necessary to those who sail the seas."[2] Alexander Neckam an English monk 1157–1217 wrote, "Sailors moreover as they sail over the sea when in cloudy weather they can no longer profit by the light of the sun x x and are ignorant to what point their ship's

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8 Chau-Ju-Kua, his work on Chinese and Arab trade in the 12th and 13th Christian centuries entitled Chu-fan-chi trans Hirth and Rockhill p 29 note: this will be found in Harvard Library word Commerce and very likely elsewhere.

9 Pp 9–10, 13, 24.

1 Pp 41–3 Klaproth Boussole.

2 Klaproth p 43; also Vol Vocabularies 1857 Wright Naturis Rerum Vitry; p xxxv preface is Eng trans of the passage. There is an ed of Vol Vocab of 1884.

course is directed touch the magnet to the needle which is whirled around in a circle until when its motion ceases its point looks direct to the north." [3]

The 3 extracts show that 1000 to 1100 the needle was known and used in Europe. The literature is considerable, Klaproth and Hirth being the principal authorities: in addition to what has been quoted reference may be made to Vincent de Beauvais and Albert the Great both of about 1250, Gauthier d'Espinois, Brunetto Latine the tutor of Dante, Roger Bacon, and others.[4] Early writers mention the advantage of the compass in cloudy weather when it alone shows direction and perhaps the water-compass was so imperfect as not to be used when the celestial bodies could be seen: this view is confirmed by a law of Alfonso the Wise King of Castile 1252–84 reciting,[5] "The mariners guide themselves in obscure nights by the needle which is the means x x to show them how to go in bad weather as in good."

HOW KNOWLEDGE OF THE COMPASS PASSED FROM PLACE TO PLACE.

The compass was used in Europe before 1100 and it remains to learn how it came there. Recent authorities have been quoted and it may be added that Vincent de Beauvais and Albert le Grand of about 1250 use the Arab words *zoron* and *aphron*, the former meaning correctly the south and the latter the north, but have both confounded their meanings; [6] Klaproth says as to incorrect use of these two words, "It follows that the polarity of the magnet was known to the Arabs before the time of Albert the Great and Vincent de Beauvais and that what the latter knew at that time came from books of the Arabs x x." [7] Klaproth says of compass-needles floating on water, "It results from all these data that this kind of compass was used in China at least 80 years before the composition of Guyot de Provins, that the Arabs possessed it at about the same time, and that consequently the invention was communicated directly or indirectly to the Arabs by the Chinese, and that it was the Arabs who transmitted it during the first Crusade to the Franks."

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[3] Vol Vocab cited note next preceding p xxxiv preface. Neckam was foster-brother of Richard of England but in the acct of Richard's Crusade there is no mention of the compass.

[4] Regarding the last two see Monthly Mag or Brit Register, 1802, Being Extr from Portfolio of Man of Letters, v 13 pt 1 p 449; also Hallam Hist Eur during Mid Age Colonial Press N Y v 3 bk 9 p 57; also Azuni Diss sur la Boussole.

[5] Duro Mar Castillo p 358.

[6] Klaproth p 50: he says of *zoron*, "It is this word from which is derived probably the *sur* of the Spanish and *sul* of the Portuguese."

[7] P 53, Siete Partidas.

It is impossible to learn how the polarity of the needle was discovered, happened upon it must have been, nor how the knowledge was propagated. Chinese works say compasses were in use at early date; Arabian ships were in company with those of China until after the date when ships used compasses generally, meeting in waters south and east of Asia, and from about 800 A D Arabian ships were all over the Mediterranean: also, before the First Crusade 1100 ships from ports of Europe were at Alexandria and in Syria. During these centuries if the instrument was used in the East it would be communicated to the West and vice versa. The break in knowledge is when did the Arabs first use compasses at sea and we have only the words of Bailak Al Kibdjak of 1242 as to this.[8]

What has been said concerns the water-compass; a float carrying a needle placed in a cup of water in a quiet place. This would give but poor means of keeping on a course in a rough sea-way and histories mention two other ways of steering: one was called " following the wind," steering before the wind or at desired angle from it which as winds usually blow themselves out without change of direction is not a bad way; the other was by keeping sun or star on a certain bearing. The last becomes impossible in overcast weather and only then perhaps the water-compass was set up. It is likely that due to their poor quality they were not much used and may have been long known to seamen before attracting sufficient attention to lead to mention in books. Following the wind is still used in sailing ships in modified way, for ships " steer small " as it is called, use little helm on one side or the other, by watching the sails; with eye always to the compass. As to steering by the sun or stars that too is still used, though it cannot be used for a long time because of motion of the celestial bodies. This way of steering becomes accurate if the astrolabe or other instrument is used.

THE PIVOTED COMPASS.

After compasses were pivoted ships carried them set up ready for use. The earliest trace of a pivoted compass is in a letter written by Petrus Peregrinus de Maricourt to a friend at his home in Picardy. He wrote from a camp where he was a soldier in 1269.[9] Peregrinus proposed to make a magnet in the shape of a globe and to hang this on axes at the two

8 Above p 266.

9 See Petrus Peregrinus de Maricourt and his Epistola de Magnete Prof Thompson in British Academy Nov 1906. A copy of the letter in the original with an English translation is in the library of Elec Engineers in New York. In the last and in Thompson's article are illustrations taken from Peregrinus' letter.

ends of a diameter, the diameter to be set parallel to the earth's diameter. The line through the magnetic poles of the globe was directed to the pole-star, for it was believed by many that magnets followed this in its motion. Peregrinus must have believed the globe would turn once in twenty-four hours as its magnetic pole followed the pole-star around the pole of the earth, "With this time-piece you will be independent of such devices as sun-dials and clepsydras," he wrote his friend.[1] Our soldier, he appears to have been of the humblest rank, was called Peregrinus because he had been to the Holy Land; his real name was Pierre and perhaps in his voyage east he learned somewhat of sea-ways for he says of his invention, "By means of this instrument you may direct your course towards cities and islands x x provided you are acquainted with the latitudes and longitudes of those places."[2] To make a clock or improve the compass Peregrinus made a great invention. A modern author has written, "Peregrinus invented the first mariner's compass which could be constantly used to steer by as we steer now instead of being merely used to indicate the direction of the pole, the first compass having a fiducial or lubber's-mark xx, the first compass being a pivoted needle."[3]

Peregrinus mounted a magnet on an axis or point, thereby making great advance on the water-compass. There is only one thing remaining to bring the compass close to ours; to fasten to the needle a graduated light circumference so that when the helmsman looks in the compass-box, Peregrinus having already added the "lubber's-mark" the line painted on the circular box bolted into the ship in which the compass turns, he sees on what point of the horizon the ship's head is. It will be remembered the compass described by Guyot de Provins was lighted for use at night. In an article called The Rose of the Winds[4] Professor Thompson says, "In or about the year 1302 the improvement was made of affixing to the pivoted needle a light circumference whereon was painted the rose of the winds;" and Mr. Benjamin already quoted supplies confirmation of this as follows,[5] about 1380, "The navigators have a compass in the middle of which is pivoted a wheel of light paper on a point which turns

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[1] P 387 Thompson's article cited note next preceding.

[2] Intellectual Rise in Electricity Benjamin p 181.

[3] P 185 work cited note next preceding. There is by the same author a work called The Age of Electricity which contains much of interest.

[4] Read Internat Hist Congr Apr 1913, from Proc Brit Acad v 6 p 3.

[5] P 191 Int Rise in Elect.

on its pivot and on this wheel the needle is fixed and the star (rose of the winds) painted."

There is a passage in a letter of Columbus written about a century later than the one last quoted which shows that his compasses were made with a wheel of light paper: the great navigator was at the Island of San Pedro near Sardinia about 1460 and an unruly ship's-company wished him to take the ship to Marseilles to get another ship to aid them;—Columbus writes, " Being unable to force the crew's inclination I yielded to their wish and having first changed the points of the compass spread all sail for it was evening and at daybreak we were within the Cape of Carthagena while all believed for a certainty that they were going to Marseilles." [6] Three remarks about this may be made; 1, It was not uncommon until after Columbus' day to *touch* a compass, to turn the card on the needle and fasten it again, it being done to eliminate appearance of variation, a strange property to Columbus when he sailed on his first trans-Atlantic voyage; 2, Columbus' crew were not ignorant else they would not have known the course from Sardinia to Marseilles; seamen before the mast would hardly know this now; 3, there is error in the run stated. San Pedro is at the S W end of Sardinia; from it to Marseilles is 275 miles N W by N and to Cape Palos just east of Carthagena W S W 470 miles. The ship might have run 470 miles in 1½ days but not in 12 hours.

APPARENTLY ANOMALOUS STATEMENTS REGARDING COMPASSES.

There are 2 passages in authors of the Middle Ages which must be noticed because often referred to and because they admit of interesting explanation. They are nearly contemporary; the first is of 1425 and by Nicolo Conti a Venetian and the second written on the terrestrial globe of Martin Behaim made about 1490 and still existing. Conti says,[7] " The natives of India steer their vessels for the most part by the stars of the southern hemisphere as they rarely see those of the north. They are not acquainted with the use of the compass but measure their courses and the distances of places by the elevation and depression of the pole. They find out where they are by this mode of measurement." The people of India had long been familiar in Conti's day with the magnet's property of pointing north, but it is possible if pivoted compasses had not penetrated so far

[6] Select letters Columbus Hakl p xxxvi.

[7] P 26 India in 15th Century Hakl: Behaim and His Globe Ravenstein. See below p 279 for another case of being deceived as Behaim was by magnetic rocks in the sea.

they used astrolabes and azimuth angles of sun or stars to steer by and found latitude by altitude of the stars of the 2 poles. This may have given rise to the statement but it is impossible seamen were not aware of the polarity of the needle.

The same is indicated by a legend Behaim wrote on his globe: in the sea near Sumatra we read, " Here the sea-star called *polus arcturus* by us is not visible and those who navigate the sea must do so with the help of the astrolabe for the compass does not point." This has brought Behaim only ridicule but there are in several places serious aberrations of the compass due to magnetic rocks, and one of the most noteworthy is off the north coast of Australia, where near a place called Port Wolcott compasses are so disturbed as to be useless. Behaim put on his globe legends such as seamen brought in and this one looks as though the report of a ship which had been near the coast of Australia had reached him. From what he says about navigating by the astrolabe as from what Conti wrote it may be inferred ships steered by azimuth tables and an astrolabe and latitude was found by altitudes with this instrument. Dead-reckoning was so every-day a matter and required so little science or mystery in use that no-one mentions it though we shall find it mentioned by seamen when we get what they wrote themselves.

CHAPTER VII.

ROUND-SHIPS IN THE WEST 500 TO 1500 A D.

Ships and Voyages Astrolabes Compasses Ephemerides.

Between 500 and 1500 A D ships and sea-faring advanced greatly in the West. In the first 500 years of the period records are meager but sufficient to show that shipping was not prosperous except that in Constantinople an ample sea-commerce flourished. Mahometan ships which destroyed those of the Christians did not go as far as Scandinavia and here shipping grew so that before 1000 the Northmen had penetrated to all parts of Europe where a keel can go and crossed the Atlantic to America. In years following came the Crusades when because of demand for ships to transport warriors and supplies to the Holy Land the number of ships increased greatly. It is said 300000 persons were thus carried by ships of Italy and France alone in the year 1096.[8] If we suppose an average of 300 in each this would be 1000 ships, nearly 3 sailing for Palestine each day of the year. We may assume they were of about 300 tons displacement; thus allowing one ton to each passenger, a small allowance, but passengers were stowed close.

If we add ships from other parts of Europe, Norway England Flanders and France, for pilgrims came also from these, the number of ships reaching the Holy Land in the year could not have been less than 2000. It is not likely many made 2 voyages within a year for business was not as hurried as now. A movement of such volume lasting for 200 years was very stimulating and ships and ways of managing them improved greatly. There appears no reckoning of the number of Christians in the Holy Land at one time though clear very nearly all persons and baggage went by sea; all who could bought a passage by ship, or where many banded together, chartered ships or fleets; only those without means set off with baggage and food to walk to the Holy Places trusting to meet Christians who would give the alms necessary to support life.

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[8] Azuni Boussole p 102.

THE NORTHMEN.

The sea-faring of the Northmen has been traced to early days [9] and by writings of the Middle Ages its later state is made clear. Before 500 A D it is not likely ships of the North went far, though there is proof of traffic with distant places from coins found in lands other than their own.[1] Though Northern ships and sea-ways were developed apart they differed little from those of the Mediterranean; the Heimskringla, a history of the North in the Middle Ages, reads like ancient Greek histories; in both the sea and ships are ever before us and allowing for difference in the sea off the coast of Norway and in the Mediterranean everything, ships sails ways of placing rowers in ships etc, is the same.

Allusion has been made to the expeditions of the Northmen to England beginning about 450 A D and continuing 600 years.[2] These sturdy rovers extended their cruises from the White Sea to the bottom of the Mediterranean penetrated the Baltic discovered the islands in the Ocean west of Africa and crossed the Atlantic to America. From Norse and other writings we learn of the ships used in these voyages. Most were long-ships; the larger and heavier round-ship is unhandy near land where exploring ships must often go, and ships which went before coasts and seas were charted must have been able to take care of themselves with oars on a lee-shore with strong wind and heavy sea. But the capacious round-ships were often with the row-ships: Laing in the introduction to his translation of the Heimskringla [3] gives estimates of weights carried by Norse war-fleets, arms stones to be thrown etc, and adds, "We find 2 transport-vessels to 10 ships-of-war in the Saga of St Olaf." Further on he says, "We need not suppose that of the 1200 vessels which King Olaf in his last levy to oppose Canute the Great had assembled and brought to the Baltic [4] the greater number were more than large boats of perhaps 30 feet keel with a forecastle deck a cabin aft and center open and tilted over at night to shelter the crew." [5] He goes on as follows about vessels called Long Serpent and Crane built about the same time, "The Long Serpent

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[9] Civilization Sweden in Anc Times; Antiq Suedoises; both by Montelius: Northern Mists Nansen Eng trans.

[1] Commerce du Levant Heyd; many old foreign coins have been found in Sweden and islands near-by though whether they came by land or sea is unknown.

[2] Above pp 2, 4.

[3] Ed cited n 4 p 2 above, v 1 p 40.

[4] In abt 1020.

[5] Heimskringla v 1 p 135.

had 34 banks for rowers and the saga gives us details concerning her; the length of her keel that rested on the grass was 74 ells:" this would be 111 feet: "She was the length of keel of one of our 42-gun frigates of 942 tons" Laing concludes; his date is 1830.

THE NORSE TRANS-ATLANTIC VOYAGES AND COLUMBUS.

Laing apparently believes Columbus conceived the idea of his voyage when in Iceland in 1477, 80 years after the saga or traditional account of Norse trans-Atlantic voyages was first committed to writing, when he may have seen or read the story or a map of the lands discovered. The question will be examined presently. It is likely the ships that happened on Greenland were searching for new lands or fishing-ground, but easterly gales of 1 or 2 days would drive a ship near Iceland as far as Greenland for the distance is only 175 miles. In regard to voyages in the North the distances to be traversed should be noted: the earliest date for Iceland in European histories is 725 when monks came there from Ireland [6] going perhaps by steps as follows:—

Ireland to Orkneys very near
Orkneys to Shetlands 60 miles
Shetlands to Faroe 180 miles
Faroe to Iceland 230 miles.

The run to Greenland from Iceland is 175 miles as just mentioned. The first ship of the Northmen to reach Iceland came in 825 being piloted by Irish monks who had long been in the island. In the place cited in the note next above it is shown ships made the run to Iceland from Orkneys or Shetlands, both about 420 miles, in 48 hours, 10 knots per hour, a speed not unlikely with a good breeze between east and south. The Northmen's coming to the northern part of what is now called Great Britain where they probably picked up Irish pilots would require only the run of 180 miles from their coast to the Shetland Islands.

That there were islands N W of Europe was known before the day of these Irish and Norwegian seamen. Herodotus knew that in the North daylights are separated by very short interval of darkness in summer; so travellers had visited high latitude by 500 B C and returned; Pytheas of Marseilles measured about 325 B C the length of days and nights in the Far North having gone by a route and means not known to an island in

[6] Below pp 280 and foll'g.

the North or to Norway: 500 years later Ptolemy drew on his maps of the North the island of Thule named first by Pytheas and described its seasons; and Procopius secretary to Belisarius writing about 550 A D describes the courses of the sun in the north as a voyager in a modern liner might when at North Cape; $71\frac{1}{2}°$ north. The north of Iceland is 66°, just outside the Arctic Circle.

Procopius' master Belisarius was the general-in-chief of Justinian the Emperor of East Rome dwelling at Constantinople, so what he writes had come across Europe. Of a band of Herulians conquered and dispersed by the Lombards he says a part,[7] "Sought a dwelling at the extremity of the earth. They traversed the country of the Slavonians and then a vast solitude beyond. They entered Danemark and arrived at the Ocean. Here they embarked and arrived at the Island of Thule. x x There is there a marvellous thing. Every year toward the summer solstice the sun appears for 40 days on the horizon; 6 months later they have 40 days of night. x x I have never been able to go to this isle x x to see with my eyes what others have recounted to me. Those who have been there x x tell me the sun lights the isle for 40 consecutive days sometimes on the east side and sometimes on the west, and that when the sun has returned to the point from which it set out they count a day. In the season of 40 nights they measure time by the moon."

THE NORSE TRANS-ATLANTIC VOYAGES.

Gunnbjorn discovered what we call Greenland in 876,[8] 600 years before Columbus was in Iceland, and was followed by others. Biarne Heriulfsson reached the coast of North America from Greenland in 986 and was followed by Lief Ericsson and Thorfinn Karlsefni. With the last came his wife Gudrid and to her was born a boy, the first of European parentage to see the light on our continent. He was named Snorro and was probably born before the year 1000. Following the coast south and west from Greenland the voyagers called the part of America nearest Greenland Markland because they found timber there and that further south and west they called Vinland because grapes were found. It is not known precisely what points were reached, for the voyagers left on the

[7] Hist Constantinople Guerre contre Goths trad Cousin v 1 p 483.

[8] Laing's Heimskringla v 1 p 154. Eric the Red coming afterwards called it Greenland because there were green things growing and it was well to give it a good name.

American continent no buildings or other permanent marks which they did do in Greenland where their ruins may still be seen; but that they reached what is now the United States there is no doubt. Some who have examined the logs of the ships believe they came as far as Cape Cod. They noticed and recorded that in Vinland, "The days and nights were of more nearly equal length than in Greenland or Iceland. On the shortest day of winter the sun was up between *eyktarstad* and *dagmalastad*."[9] Another passage which has been preserved, curious but perhaps not important, for it may be spurious, is as follows; while in Baffin's Bay in 1267, "The sun shone both night and day and when it was in the south was only so high that if a man lay athwartships in a 6-oar boat the shadow of the gunwale nearest the sun fell on his face; but at midnight it was as high as it is at home in the settlement when it is in the north-west."[1] At the time of these voyages Iceland was a place of learning and many living there were proficient in science.

Whether Columbus would be interested in the Norse voyages west would depend on how far south they had extended. He wished to reach the rich East Zipango and Cattigara and the discovery that by sailing west from Iceland 175 miles land would be reached would hardly have interested him, but if told ships had followed the land far south and west his attention may well have been aroused. Where the new land was would be clear if the Norsemen had made a chart and though we have no word of their having done so it is unreasonable to doubt this.

A POSSIBLE VOYAGE MADE TO AMERICA IN 1370 BY THE ZENO BROTHERS, VENETIANS, AND THEIR MAP.

Much controversy has arisen about this which it is not worth while to enter upon.[2] Mr Major and Mr Lucas respectively believe and disbelieve the tale and while it is impossible to decide which is right the subject is interesting in the history of discovery; particularly the map, *Carta de Navegar de Nicolo et Antonio Zeni, l'Ano 1380* is inscribed on it. What-

9 Finding of Wineland (Vinland) the Good Reeves 1895 p 66; a note gives some explanation of these words but it seems impossible to translate them into latitude; yet the person who used them must have known what he meant in terms of latitude.

1 Northern Mists Nansen v 1 p 308; see pp 248–50 for views on the navigation of the day.

2 Major Voyages of Zeni Hakl; Lucas Voyages of the Brothers Zeni, London, 1898: references to authorities will be found in both. The map alluded to just below is reproduced in Major's work.

ever we may believe, whether that the Brothers proceeded as far as the head of Chesapeake Bay, the belief of advocates of the truth of the story, or reached only an island north of Britain or as far as Iceland and later the story was fraudulently trumped up it is plain that long ocean voyages and map-making were common before the year 1350.

THE LOGS OF THE NORTHMEN'S SHIPS.

Mr Major who long studied the history of discovery by sea has followed the reckonings of the ships that crossed to America before 1000 A D and writes,[3] " It is fortunate that in their accounts the Northmen have preserved the statement of the course and distance sailed in a day. It is from these reckonings that charts of the voyages have been reconstructed." If logs showing courses and distances for each hour or even each day had been kept the tracks of the ships and lines of the coasts they followed could be laid down with precision; but in years 850 to 1350 when the voyages were made this was not practiced with modern nicety: not until about 1625 did ships keep records like those now kept. Even in respect to Columbus' first voyage the land-fall is still in question and learned men of Spain and Portugal long disputed the position of the Spice Islands, though many Portuguese ships had sailed there going east and many Spanish going west, while all kept a reckoning. Reeves confirms in his Finding of Wineland the Good what Major says of the reckonings of the Northmen examines day's-runs in general and quotes an early voyager who says he,[4] " Lost all reckoning." Since upon an occasion the reckoning was lost it must usually have been kept.

THE SHIPS USED IN EARLY TRANS-ATLANTIC VOYAGES.

The ships in which the Norse voyages were made were small compared with those of our day, not completely decked but staunch and sea-worthy for Norse ships had these qualities. The ships crossing to Greenland and America brought provisions and baggage women and young children live animals of several kinds, and were equipped with places which could be kept dry for we read in one place of delicate clothing brought out to the colonies.[5]

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[3] Sel Letters Columbus p XVIII, Hakl.
[4] Pp 40, 70.
[5] Wineland the Good Reeves p 168.

THE BUILDINGS FOUND IN GREENLAND.

The colonists in Greenland erected buildings of which the ruins still exist and ships from home came out regularly until 1400 when the settlements were deserted or over-run by hostile natives. Their whereabouts even were forgotten, for Magnus Heinson a renowned seaman was sent in 1578 by the King of Denmark to re-locate his lost possession. Heinson, "Obtained sight of the coast of Greenland but after proceeding for some time towards it without appearing to come any nearer xx he became alarmed tacked about and returned to Denmark. On his arrival he attributed this extraordinary circumstance to his vessel being stopped by 'Lode-stone rocks.'"[6] This is a modern case of an old and widely received belief now known to be justified: Heinson may have had good cause for alarm for his ship had entered a region where because of lodestone rocks in the sea the compass is useless unless the amount of perturbation has been previously ascertained.[7]

LAWS IN THE NORTH.

Commerce was regulated in the North from 1150 by the Laws of Wisby.[8] These were drawn up after traffic had become of importance. They furnish good indication of what the round-ship of the day was; they anchored off-shore as large vessels have always done and communicated with the shore by small boats.[9] Ships had one mast, as the mast is referred to in the singular, and as always in early days merchants were consulted regarding the conduct of the vessel. This custom ceased only when merchants ceased to accompany their goods abroad; almost within recollection of persons now living. The Laws of Wisby are sober temperate rules regarding ships and their ways; of character very different from what we find in the Heimskringla where the exploits of vikings in long-ships are dealt with.[1]

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[6] Voy to Northern Whale Fishery Scoresby p XXXV.

[7] It is known such perturbations occur off the coast of Greenland. See above p 271 as to another case of similar character.

[8] Pardessus Coll v 1 p 426. Wisby was in the Island of Gothland; in the Baltic south of Stockholm.

[9] Pardessus cited prec note v 1 pp 463–502: the code given is copied from one printed in Copenhagen in 1505.

[1] As regards the Northmen see Barlow Normans in Southern Europe; Keary Vikings in Western Christendom; Forster Voy and Discoveries in the North; DuChaillu Viking Age; Fischer Disc of Northmen in America; and works cited notes 9 and 1 p 274 above.

OTHER VOYAGES IN THE NORTH.

As noted Irish monks went to Iceland about 725 A D to pursue their devotions unmolested; for which fact we are indebted to Dicuil who lived about 825 and was himself an Irish monk.[2] Dicuil says the first Irish monks went north 100 years before his day but does not say how they came on Iceland or whether they previously knew its whereabouts. While in Egypt he says he passed through the Nile-Red Sea Canal [3] and tells another interesting thing; he says a ship, " Sailing with full sails and with favorable wind always " will reach Iceland from the Shetland or Orkney Islands in, " Two days and as many nights." [4] The distance is 410 or 470 miles; thus ships made 8 to 10 miles per hour with good and fair wind, the same as now.

In the works listed in the 4th note above may be read what the Northmen accomplished in early days. They passed north along Norway around North Cape and coasted the north of Europe and explored the White Sea; discovered though not the first of Europeans Faroe and Iceland; and were first of Westerners in Greenland and America. They appeared in France in 515; in England about the same date whence they have never been driven; [5] in 862 Rurik the Varangian founded what was to become the Empire of All the Russias; about 845 they sacked Paris and 10 years later entered the Mediterranean: here in 1058 under Robert Guiscard they drove the Saracens from Sicily and set up their Kingdom; the first to break Mahometan power in western Christendom, for the peninsula of Spain northern Africa and the islands of the western Mediterranean were in the hands of the Infidel. The western Mediterranean was a Mahometan lake whose shores were kept in terror; here Christian ships might not sail.

A recent author writes of the sack of Paris in 845,[6] " Now no doubt began to rise up in half the churches in Francia that despairing cry, ' From the Northmen's fury Good Lord deliver us,' which in some churches survived until quite modern days." But though accompanied by violence the effect of Norse sea-expeditions was beneficial; large parts of the earth

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[2] Letronne Rech xx DeMensura Orbis Terræ xx par Dicuil; Dicuil wrote a work on astronomy which has been published but not trans from Latin; he speculates therein about a south pole-star. See p 275 above as to distance from Ireland to Iceland.

[3] Above p 5.

[4] Work cited note 2d above p 132.

[5] Above p 4.

[6] Keary Vikings in Westn Christendom p 260.

were explored, more than one modern state was founded and wisely ruled, they first broke the ring the Mahometans had forged in the West, and becoming Christians about 1000 they came to the Holy Land in their ships and aided valiantly in the common cause. First of all perhaps, Norse seamen wrote or dictated records which have survived; in these we read such things as chroniclers writing from hearsay and tradition would not have set down: after a sea-battle at Aarhuus in North Jutland a viking sings,[7]

" A Gothland shield and breast-plate true
Fell to my share of spoil by lot
And something more in the south I got;
There all the summer swords were ringing;
A helm gay arms and gear worth bringing
Home to my quiet lovely one
I sent—with news how we had won."

It is claiming much for the vikings so often deemed pirates to say they wrote their own records, but only those who had been in ships and taken part in battles on sea and land—changing from one to the other as readily as the Greeks of old—could have composed the northern sagas. Here is a good place to mention that the word *viking*, often held to mean a *sea-king*, is an old Norse word meaning *son of the fiord*.[8] Like all peoples who have played great parts the power of the Northmen was in their ships.

OTHERE AND WULFSTAN NORTHERN VOYAGERS.

The people of England, in no inconsiderable measure of Norse origin, have left early records of ships and voyages. It has been mentioned that Offa King of Mercia in England about 750 and Alfred the Great King of England about 871–96 held power at sea in high estimation and built ships.[9] Alfred's activities were many; among other things he translated the History of Orosius written in Latin in 400 A D into Anglo-Saxon and puts these words of his own into his translation, " Othere told his Lord King Alfred that he dwelt northmost of all the Northmen. xx He said that he was desirous to try how far that country extended due north or whether any-one lived to the north of the waste. He went due north along the country having all the way the waste-land on the right and the wide

[7] Heimskringla Laing p 393 v 2: other extracts are below pp 392 and foll'g.
[8] Fiske Disc America v 1 p 151 note.
[9] P 4.

sea on the left for 3 days. He was as far north as the whale-hunters go at the farthest. Then he proceeded in his course due north as far as he could sail within another 3 days. Then the land there inclined due east or the sea into the land he knew not which. He waited there for a west wind or a little north, and sailed thence eastward along that land as far as he could sail in 4 days. Then he had to wait for a north wind because the land there inclined due south or the sea in on that land he knew not which. He then sailed thence along the coast due south as far as he could sail in 5 days. There lay a great river up in that land. They then turned up in that river because they durst not sail on by that river on account of hostility, because all that country was inhabited on the other side of that river xx. He went thither chiefly in addition to seeing the country on account of the walrusses; xx their hides are good for ship-ropes." [1] Just following his interpolation in Othere's words Alfred gives these words of another voyager, " Wulfstan said that he went from Schleswig to Truso in 7 days and nights that the ship was all the way running under sail." This is nearly east across the bottom of the Baltic Sea, from near Kiel to the bottom of the Bay of Danzig; the distance is 400 miles so the ship made good 60 miles per day.[2] King Alfred sent two priests Sighelm and Æthelstan to India and Rome in 883; but we have no details of their voyages.[3] Something of interest should be in the history of whale-fishing but this adventurous calling though taken up in early times along the western shore of Europe has left little record: [4] the words of Othere just given show whale-hunters went far north on the coast of Norway before the day of King Alfred.

THE CRUSADES.

We come now to the Crusades waged by Christian Europe to drive the Infidel from the Holy Places. These had great effect in sea-faring. They began when in 1095 Peter the Hermit led an unorganized army of 300000 by land to Syria and captured Jerusalem, and ended 1291 when Acre the Christian port of entry in Syria was captured; upon this the Christians retired to the Island of Cyprus. The call for ships to carry

1 See version of Orosius in work cited p 191 n 1 above. There is another edition of this, Bohn 1857.

2 P 253 work cited note next preceding.

3 Beazley Dawn Mod Geog v 1 pp 203, 214: Nicolas Hist Roy Navy v 1 p 14 says after Sighelm India was not visited by an Englishman for 8 centuries.

4 See however the work of Scoresby cited note 6 p 279 above; also Account of the Arc Regions with Hist and Desc of the Northern Whale Fishery same author 2 vs 1820.

Crusaders out and support them led to building many [5] and making them larger and rigging them better. The owners of the ships were too keen not to understand as the poet Hesiod did many years before [6] that gain is greater in large than small ships; they understood too that ships well rigged and sailed making voyages quickly and handled by few men earn profits where others show losses and thus the art and science of ship-building and operating prospered mightily. We shall come to this again in a chapter on long-ships; where because Crusading fleets were composed of these, though round-ships were in company with supplies, the histories written by men who were in the fleets have been placed.[7] The writings of the chroniclers of the Crusades are among the earliest in the languages which came from the Latin and the first narratives written or dictated by seamen; unless indeed the Northern Sagas precede them in this respect. In the chronicles of the Crusades there is much regarding ships and their size: St Louis Louis IX of France went to the Holy Land with a crusading fleet in 1268 having hired 15 ships in Venice 3 from the Republic and 12 from private merchants: "These 15 vessels carried to the Holy Land 4000 horses and 10000 soldiers" we are told.[8] The crew proper of each ship is given as 110 men; thus assuming uniform distribution there were 266 horses and 770 persons in each vessel: the water fodder provisions and baggage must have been prodigious for a man requires his weight in water and food every fifteen days and horses corresponding amount. The ships must have been supplied for not less than 20 to 30 days.

THE PART SHIPS AND SAILORS PLAYED IN THE CRUSADES.

For 200 years Europe strove to conquer the Holy Land being impelled by a passionate religious conviction fanned into flame and guided from Rome; and through these years great numbers of Christians were carried to Syria in ships and supported there; but not all returned for many perished by the sword and disease. The beginnings of this movement of ships, the greatest in the history of the world if we consider all facts, lie in early date and are small in volume; they are found in and before the year 300 A D when Christian pilgrims began in numbers to go to Jerusa-

[5] Above p 273.

[6] Above p 12.

[7] Below pp 402 and foll'g.

[8] Formaleone Mar Anc Venet 1788 p 31; the author says this is from contemporary authority.

lem.[9] Until the rising of Mahometanism devout persons continued to make this journey and though then interrupted for a time the movement began again when the first fury of the followers of Mahomet was passed, for Venetian ships brought the relics of St Mark the patron of their city from Alexandria to Venice in about 800 A D, where his church was founded in 829. Ingulph a priest and secretary to William the Conqueror writes of Genoese ships in the East in 1050,[1] but the Amalphitans supply the most interesting information as to Christians in Palestine. Merchants of this city trading in Jerusalem obtained in 1023, 75 years before Crusaders came there, permission to build a hospital for sick and indigent Christians,[2] and from this grew the Order of the Knights of St. John famous in Crusading days and until almost now. The Knights were priests and soldiers and after fighting valiantly in Palestine retired to Rhodes when Christians were expelled from Syria and from there were forced by the Turks successively to Crete Sicily and Malta. Being islanders they maintained a fleet and its story has been written by Adm de la Gravière of the French navy and respecting his own time by Bosio in his Histoire de Malthe. In the First Crusade Niceæ in Asia Minor in the path of the army advancing to Jerusalem was captured by ships conveyed on wheeled vehicles 7 miles overland in a night.[3] Shortly following this success the Crusaders invested Jerusalem June 1099 and the city fell July 15 1099, 5 weeks after investment and some 3 years after the army set out from numerous places to march overland.

The shipping of Venice was at this date the most numerous of states bordering the Mediterranean and to it fell the largest share of the traffic of the Crusades, the magnitude of which may be realized by the fact that upon its becoming necessary to limit the number of pilgrims that could be carried, military and religious orders were prohibited to transport more than 6000 in one year.[4] The Venetians were early in sending a fleet for in

[9] Above pp 219, below 361.

[1] Ingulph's Chron Bohn Antiq Lib p 149: Ingulph went from Syria to Brindisi in a Genoese round-ship; he, "Committed himself to the sea and after being tossed by waves and storms innumerable arrived at last at Brundusium." See also Hist de Genes Vincens p 40.

[2] Hist Croisades Guillaume de Tyr in Coll Mem Rel Hist de France Guizot p 82 v 3; Crusades Story of Nations p 170.

[3] Below p 387.

[4] Hist Com entre le Levant et Europe xx Depping v 1 p 282. We have no statement why the number was limited but it may have been because of difficulty of provisioning too many.

1098 they sent 200 fighting-ships and necessary transports, which on the way out came to blows with a Pisan fleet bound to the Holy Land. These blockaded Joppa the sea-port of Jerusalem during its siege alluded to thereby preventing succor reaching the city.[5]

ENGLISH FRENCH AND NORSE FLEETS IN THE HOLY LAND IN 1190.

There is not space to review the operations of the Crusades and they are so involved, various, indifferently recorded and complicated by clashing of Christians that an attempt could hardly end satisfactorily,[6] but much may be learned of the ships and their ways from the histories sometimes written by eye-witnesses of various undertakings: for example, a fleet sailed from England in the spring of 1190 and reached Acre in Syria in 12 months as is told by Richard of Devizes and Geoffry Vinisauf who went in it.[7] A few years earlier King Sigurd sailed from Norway for the Holy Land with 60 ships: as a saga recounts,

"To the distant Holy Land,
A brave and pious band
Magnificent and gay,
In sixty long-ships glide away." [8]

Sigurd crossed to England in the autumn of 1107 and remained there all winter. In the autumn of 1108 he had reached Galicia and here passed a second winter. In the following spring the fleet fought Saracen fleets off Spain and Portugal several times; it passed the Strait of Gibraltar, which they call Norfa, from the name Norva of the first viking who passed there, and went on to the Balearic Islands. From here it came to Sicily being then 2½ years out from Norway. Here Sigurd assisted at the coronation of his countryman Roger as King of Sicily. After operations in the Holy Land Sigurd went back to Norway overland by way of Con-

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[5] Hist Rep Venise Daru 1826 v 1 p 108. The number of ships in this Venetian fleet is confirmed by Sismondi Hist Rep Italiennes p 346 v 1: there is an ed in one v in English. The hist of Venice Genoa Pisa Amalphi are sea-tales equally with that of Tyre Athens and the Norseland.

[6] In Du Sein Hist Mar de Tous les Peuples 2 vs 1879 are described all actions between fleets.

[7] Below pp 402 and foll'g. Those disposed to find fault with the slowness should look into the time D'Estaing's fleet was crossing the Atlantic when sent to this country in our Revolution or the time the Russian fleet defeated at Tsu-shima occupied in reaching Japan.

[8] Thorarin Stuttfield; in Laing's Heimskringla v 3 p 149. The term *long-ship* should be noted; the norse word is *lang-skip*.

stantinople disposing of his ships at the latter place. In going through the Dardanelles he was desirous of showing the beauty of his sails to the people on shore; "Here," the saga tells, "He lay still a fortnight although every day it blew a breeze for going before the wind to the north; but Sigurd would wait for a side wind so that the sails might stretch fore-and-aft in the ship, for in all his sails there was silk joined in before and behind in the sail xx." Sigurd was fond of bluffing; in riding through the streets of Constantinople, " It is told that King Sigurd had his horse shod with golden shoes xx and managed so that one of the shoes came off in the street but that none of the men should regard it xx." [9]

THE KINDS AND SIZES OF SHIPS.

Sigurd's fleet was composed of 60 long-ships but very possibly he had round-ships with him to carry soldiers baggage etc. A historian of our day writes of round-ships, " Many could carry 1000 passengers; the 2 vessels which were freighted each year by the Order of the Temple and St John received 1500. The average tonnage was 1000 to 1200 quintals that is 500 to 600 tons by our modern system. The *naves* or vessels of commerce xx had 2 or 3 decks. The stern was protected by a castle xx and ordinarily carried balistæ and other war-machines. Besides the bowsprit the naves carried 2 masts xx and 6 sails xx; the stowage and installation of passengers was the object of regulations." [1] Jal gives dimensions of ships of these days as large as any built before ships were made of iron: [2] he writes of a ship which brought from Constantinople all the Venetians in that city in 1170, " If vessels of Marseilles carried 1000 passengers in ordinary circumstances if the *nef* of St Louis received 800 pilgrims among whom were all the members of the royal family to whom space could not be allotted as rigorously as to common people, shall I be contradicted if I say this Venetian nef carried 1500 persons with necessary supplies and some of their most valuable baggage:" he quotes Villehardouin the historian of the siege of Constantinople in 1204 as saying, " In these 5 nefs were 7000 armed men " and adds, " It is generally

[9] These passages are in Laing v 3 p 157.

[1] Pigeonneau Hist Com de France v 1 p 144. P 143 same v says each vessel returning from the Orient was obliged to bring one large torsion balista, a standing cross-bow. Modern books mention this stipulation and some say it was because these could be made only in the East, but I have never seen the original authority for this cited.

[2] Arch Nav v 2 Mem 6 Principal Rd-Ships of Middle Ages.

believed the nefs of the Middle Ages made coasting voyages only; that this is an error is show by many facts." [3]

THE WAYS LONG- AND ROUND-SHIPS MADE VOYAGES AND THEIR PERFORMANCE AT SEA AS RECORDED BY A WRITER OF 1400 A D.

There is a statement belonging in 1400 of satisfactory character contrasting ways of long- and round-ships: Messire Jean de Bethencourt a French nobleman went south along the west coast of Africa in that year and it is written in his record,[4] "It is only 150 French leagues from Cape Bojador to the River of Gold and so the map has shown it to be; this is only 3 days' voyage for a nef, galleys that hug the shore take longer." Thus row-ships still in this late day were used for passages in the open sea; but as always carrying little food and water and many men, they touched often and were slow for long voyages. The nefs round-ships do 150 miles per day. We shall read of long-ships again in war-fleets but this is nearly their last appearance as carriers of passengers or cargoes.

THE VOYAGE OF VON SUCHEM; 1350.

There is a narrative which bears out what Jal says of the passages of round-ships: Jal probably never saw it. It is by Ludolph von Suchem and with the story of Felix Fabri which follows it below is our most interesting and informing account of Middle Age ships. Von Suchem's words are as follows,[5] "In general men sailing from the west to the east are wont to make provision of food for 50 days though when sailing from the east to the west they are wont to provide food for 100 days because the ship always flies as it were from west to east with a fair wind making more way in the night than in the day and travelling fully 15 miles in every hour of the day x x. Wherefore one sails much slower over the sea when returning than when going thither and especially because great ships going from the west to the east are wont to return in the months of September and October. But galleys and vessels of that sort begin their voyage thither from hence in August when the sea is smooth for in November December and January

[3] Arch Nav v 2 pp 148, 149, 263.

[4] Conquest of Canary Islands in 1402 Hakl p 102. See below p 322 for other almost co-temporary acct of voyaging.

[5] Desc Holy Land and the Way Thither Written in the Year 1350; Lib Pal Pilgrims Text Soc 1895.

no vessels can cross the seas because of storms. Howbeit no vessel can except very seldom return without toil peril fear and tempest. xx As the perils of the sea arise from divers causes I have thought it well to tell somewhat about them xx:" then follows much about dangers; our author continues: "Whosoever then would visit the Holy Land or the parts beyond the sea must travel thither in a ship or galley. If he travels in a ship then he passes straight across the sea not putting into any port unless forced so to do by contrary winds want of food or some such matter of prime necessity, and so leaves Barbary on his right hand towards the south, and leaves Greece on his left hand towards the north. He gets a distant view of many famous islands; to wit Corsica Sardinia Sicily Manta Goy Scarpe Crete Rhodes and very many other islands both great and small, and after seeing all these he arrives at Cyprus. But if he crosses in a galley: you must understand that a galley is a sort of oblong vessel which journeys from one shore to another from one port to another keeping ever close to the beach and always putting into harbor ashore for the night. It has 60 benches on either side and to each bench belong 3 sailors with 3 oars [6] and one archer. Onboard of a galley fresh provisions are always eaten which cannot be done in a ship xx:" the narrative proceeds about other matters and regarding the port of Cagliari in Sardinia continues, "On Ascension Day in the year 1341 we were driven upon this island in an exceedingly great ship by a most furious and violent tempest which suddenly arose so that it took us 15 days to recover the distance which we ran before the storm from the 6th hour to the time of vespers. xx The same night that we were driven thither 34 other great ships assembled there which had like ourselves been driven thither from divers parts of the sea and numberless other craft both great and small, some of which had cast their cargo over-board and some were damaged. Among all these ships there came the greatest ship in all the world from Naples laden with a thousand tuns of wine of the largest size with more than 600 men and divers kinds of merchandize with which she was bound for Constantinople but was driven back by the violence of the storm. xx There are in Cyprus exceeding rich citizens and merchants and no wonder seeing that Cyprus

[6] Zenzile rowing, above p 77. They had 360 oars and 360 oarsmen and 120 fighting-men. The words as originally written are rarely found in libraries: even when they have been printed and sometimes re-printed copies are not found. It is unnecessary to refer to the great value of the originals.

is the furthest [7] of all Christian lands wherefore all ships both great and small and all merchandize of whatsoever kind and from whatsoever country must needs come first of all to Cyprus and can in no wise pass by it. Moreover all pilgrims from all parts of the world whatsoever when bound for parts beyond the sea must needs come to Cyprus, and every day from sun-rise to sun-set one hears rumors and news there xx. One sails from Cyprus to some one of the cities by the sea in either Egypt or Syria. These cities are as follows, Alexandria Tripoli Beyrout Byblium Jaffa Sidon Tyre Acre." Then follows a tale about numberless partridges that in Egypt follow whistling men with allusion to the Book of Isaiah ch 18, 1 where Egypt is called, " A land shadowed with wings." Our author says of trade from Egypt to the Far East, " In the Red Sea there is a castle belonging to the Soldan wherein noble Christian captives are imprisoned. Moreover this castle keeps guard lest any Latin or man from this side of the sea or born in these parts should pass by it to India, lest they should bring home any tidings of the power and condition of the people in parts beyond the sea or of Prester John and the Indians or carry letters to them, for it would be easy to sail down the Red Sea to the Ocean and to India if this castle did not stand in the way. But the Indians and Eastern merchants may pass that way as often as they please. Howbeit I know bishops and lords who are ever wont to send accounts of this part of the East and all kinds of news across the sea to Prester John."

PILGRIMAGE OF ARCULFUS 670 A D.

Following the story of von Suchem [8] is that of Arculfus who was in the Holy Land in 670, 700 years before von Suchem. In returning to Gaul his native country, " The ship in which he sailed was after many wanderings brought by a contrary wind to our island of Brittain." Here the story was written out and in it we read that at Alexandria, " Is a very high tower which the Greeks and Latins have in common called from its use *Pharus* because it is seen by voyagers at a great distance xx that they may recognize the proximity of land by the light of the flames xx. Men are accordingly employed there by whom torches and other masses of wood which have been collected are set on fire to serve as a guide."

[7] The word *east* should be inserted; after Acre in Syria fell Christian ships stopped at near-by Cyprus. From the 6th hour to the time of vespers is from noon to 6 p m.

[8] In work cited 3d note above v 3: that a Christian pilgrim should be in the Holy Land in 670 speaks well for the humanity of the Mahometan.

VOYAGE OF FRESCOBALDI; 1384.

Nicolo Frescobaldi a Florentine was in the Holy Land in 1384 nearly the same time as von Suchem and left account of his experiences.[9] He sailed August 1384 from Venice in a merchant-vessel, a *coccha* he calls her, of 700 tons and reached Alexandria in 23 days having touched at 3 intermediate ports for cargo and paid 17 ducats passage-money. At Alexandria the customs officials came aboard and, "According to custom," writes Frescobaldi, "Took away the sail and the helm." Alexandria had then a population of 70000; "The canal of the Nile to Alexandria was still in good order and the city received by it much merchandize above all silks spices and sugar."[1] At Cairo Frescobaldi, "Saw as many vessels as there are in the ports of Venice Genoa or Ancone; they were for the most part of 400 tons burden."

VOYAGE OF FELIX FABRI; 1480.

The wanderings of Felix Fabri[2] were 125 years after von Suchem and Frescobaldi being in about 1480. Suchem and Fabri, the first 100 years after the end of the Crusades and Fabri 100 years later again, show what going to sea about the day of the Crusades was. Fabri alludes to the Spice Islands and Japan showing he knew the existence of Far Eastern lands. "We all of us," he writes, "Pilgrims and others went onboard the galley and the number of pilgrims was 110 and that of all the people who embarked in the galley altogether was 330." Then follows 19 articles of agreement between passengers and the master of the ship from which it is clear that though the conditions onboard were almost intolerable yet passengers fared as well as could be managed. The voyage was as always in galleys coasting and they were rarely out of sight of land. It began at Venice June 1 and they sent a boat ashore in Palestine July 2. Boats were carried both inboard and hoisted at davits as we shall find stated. The rowing was zenzile the rowers were slaves and the ship had a cooking-galley in her waist where was the necessary interruption in her thwarts and rowers; on the other side in a similar interruption a boat resting on a support was carried. The ship was too large to go to the

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[9] Hist Com entre Levant et Europe Depping v 2 pp 299–307.

[1] This may mean the Nile-Red Sea canal or only a local canal. A ducat was about $2.25; so he paid $38.25 for a 23-day passage probably bringing his own food onboard with him. It should be noted that both this man and Suchem say ships from the East came up the Red Sea.

[2] Pal Pilg Text Lib 2 vs 1897.

beach and communicated with the land by small boats; she had 60 thwarts for rowers and was about 150 feet long and 18 beam.

Only salient points of the narrative are given though all is of interest. Fabri does not deem the ship very large for he says, "We rowed also to the place where ships of the largest size lie and went onboard some of them. We were astonished at what we saw and wondered how the water could support such huge structures and such vast weights." These were round-ships, deeper and wider than galleys but not longer. Our author goes on, "A galley is one of the middle-sized kind of sea-going ships and is not of the greatest nor yet of the smallest sort. This vessel is named in Latin a bireme or a trireme xx. Now a bireme is one that is rowed by pairs and pairs of oars but a trireme is one that is rowed by 3s and 3s of oars because on each bench it has 3 oars and as many rowers. Now the galley in which I crossed the second time had 60 cross-benches and on each bench 3 rowers with their oars; and if it be equipped as a war-galley it has an archer with his bow on every bench together with the rowers. The length was 33 cubits understanding by a cubit as far as a man can reach with both of his arms stretched out. This length is the measurement from the prow even to the stern and the breadth thereof is 7 cubits measuring across by the mast.[3] xx The prow like-wise has a sail of its own named *dalum* which is commonly called *trinketum*, and it has beneath it a small chamber wherein ropes and sails are stored and therein sleeps the captain of the prow who has a crew of his own xx. The stern xx is much higher than the prow having upon it a building which they call a castle. From it there hangs down into the sea the rudder or rudder-post above which in a latticed chamber is the steersman holding the tiller in his hands. The castle has 3 stories; the topmost, wherein is the steersman and the compass and he who tells the steersman how the compass points and those who watch the stars and winds and point out the way across the sea; the middle one wherein is the chamber of the Lord and the captain of the ship and his noble comrades and mess-mates; and the lowest one which is the place wherein noble ladies are housed at night and where the captain's treasure is

[3] This would be across the *telaro,* outrigger-frame carrying the tholes of the oars. The measurements stated make the vessel's length 4.7 times her breadth but the width across the main part of the ship not the telaro would be less; perhaps 5 cubits, when the ratio of length to breadth would be 7 to 1. The length 33 cubits means 198 feet over-all length. If thwarts were 2½ feet apart which would be close for zenzile rowing the length of the oar-chamber was 150 feet, leaving 25 feet forward and aft in which there were no oars. See p 89 above as to telaro and pictures pp 77, 81, 359 of vessels of this class.

stored. This chamber receives no light save through the hatchway in the floor above it. On either side of the poop hang the boats one large and one small which in harbors are lowered into the water and used for landing people. On the right hand side are the steps down which one goes to the boats at sea or up which one comes from them. The poop has also its own sail which is bigger than the sail at the prow and which they call the *mezavèla*, that is the middle sail.[4] xx Two benches beyond the house on the poop on the right hand side is the kitchen which is not covered in; beneath the kitchen is the cellar and beside the kitchen the stable for animals for slaughter xx. Further on on the same side are cross-benches with oars all the way to the prow. On the left hand side there are rowers' benches all the way from the poop to the prow and on every bench 3 rowers and an archer. Between 2 benches on the edge of the ship on either side there hangs a *bombarda* in a movable iron swivel and on either side there is a *bombardana* from which in case of necessity stones are shot forth. In the midst of the ship stands the mast which supports the yard with the *accaton* or main-sail. xx In storms they set a square sail of stout canvas which they call *papafigo*. Now on this upper deck dwell the officers of the galley and galley slaves each man on his own bench and there they sleep eat and work. xx Close to the mast is the main hatchway through which one descends by 7 steps into the cabin, which is the place where the pilgrims live or where the cargo is put in galleys-of-burden."

Then follows description from which it appears passengers slept below-decks lying athwartships and very close, the space below the deck on which they lay being filled with sand-ballast, foul beyond description. The 7 steps down into the cabin indicate the head-room there was a scant 4½ feet. The ship had 2 decks probably complete end to end. Some description of how bilge-water ran is given; then the author goes on, "The noble captain xx does not interfere with the art of navigation nor does he understand it but merely orders the ship to be sailed hither and thither xx. He chooses and hires a brave man experienced in naval warfare and appoints him chief of the armament or what they call *master-at-arms*. He provides the galley with cannon catapults bows spears xx. Another powerful officer of the ship is called xx the pilot. He knows the safest and nearest courses across the sea and the ship's course is directed by his orders and advice. Should he come into a part of the sea with which

[4] Description of sails is in Jal's Arch Nav.

he is unacquainted he causes them to put into the nearest port and there lays down his office while the captain engages another pilot. xx With this same pilot are certain cunning men astrologers and sooth-sayers who watch the signs of the stars and the sky and decide which winds will blow and give advice to the pilot himself. These men are all alike so learned in their art that by looking at the heavens they can foretell storms and calms xx. At night they know all the hours by looking at the stars. Beside the mast they have one compass and another in the uppermost chamber of the castle and a lamp always burns beside it at night, nor do they ever turn their eyes away from it when sailing at night but one always gazes at the compass and chants a kind of sweet song which shows that all is going well, and in the same tone he chanteth to him that holdeth the tiller of the rudder to which quarter the rudder ought itself to be moved; nor does the steersman dare to move the tiller any way whithersoever save by the orders of him who looks after the compass wherein he sees whether the ship be going straight or crookedly or side-wise xx. They have also other instruments by means of which they learn the courses of the stars the blasts of the winds and the paths of the sea; for instance, they have a chart which is an ell long and an ell broad wherein the whole sea is drawn with thousands and thousands of lines, and countries are marked by dots and miles by figures. In this chart they observe and see where they are even when they can see no land and when the stars themselves are hid by clouds. This they find out on the chart by drawing a curve from one line to another and from one point to another with wondrous pains.[5] They have also many other instruments with which they find their way over the sea and they sit together every day conferring about them. xx When the wind is quite fair and not too strong xx all is still save only he who watches the compass and he who holds the handle of the rudder, for these by way of returning thanks for a happy voyage and good luck continually greet the breeze, praise God the Blessed Virgin and the saints one answering the other and are never silent as long as the wind is fair. Any-one onboard who hears this chant of theirs would fall asleep xx."

A pretty picture easily appreciated by those who have heard the pleasant sounds in a sailing-ship in fine weather; but conditions were very

[5] There is an English ell of 1¼ yards 45 inches still used; a French one of 45 inches; and an ell in Holland is one meter: so this chart was about 4 feet square, a size commonly used now. If it just included Venice and Alexandria, as they are 1500 miles apart, its scale was 1 inch to 30 miles; a fair day's-run was 3 inches long.

different between-decks where passengers were huddled when weather was rough and hatches battened down. There is another volume of Fabri's story but while it has much of interest it cannot be reproduced here.

THE PILOT-HOUSE IN FABRI'S SHIP.

What was in the high latticed chamber in the castle at the stern in Fabri's ship? There was a compass pivoted not a float in a cup of water a light circle was pinned to the needle and on this the divisions of the horizon were marked; inside the box in which the compass was carried the lubber's-point was marked to show where the ship's head was. The compass beside the mast on the main-deck was a "tell-tale" for the pilot who was often on the main-deck; at all times he could see the men in the chamber were keeping the course. The compasses were lighted at night; there was not one before the helmsman as now but another man watched one and gave him orders, a clumsy plan we shall say. There was an excellent chart, as convenient as those now used, a book or more likely written manuscript containing astronomical data, declinations etc; a graphical appliance to derive northing southing easting and westing from courses and distances run, that is a *martolojo;* [6] an astrolabe quadrant and perhaps fore-staff to measure altitudes and azimuths; but there is no indication of anything to measure or estimate the ship's speed.

MEASURING THE SHIP'S SPEED.

The simple appliance we call a log is nowhere alluded to as early as the date of Fabri and will not be found in the story of the voyages of Dias Columbus or Da Gama, but Magellan who sailed from Spain in 1519 had an apparatus for measuring speed. It is mentioned in so few words that we cannot tell just what it was: Pigafetta who was with Magellan and is the principal chronicler of the voyage writes when the ships were well out in the Pacific,[7] "Daily we made runs of 50, 60, or 70 leagues at the catena or at the stern." The word *catena* means a chain as seems admitted by all who have examined what Pigafetta wrote and how a chain could be

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[6] P 330 below. Our author does not unduly overstate when he says the chart had thousands and thousands of lines on it; see Carte Pisane p 297 below.

[7] Magellan's Voyage Pigafetta Orig Text Robertson Cleveland 1906 v 1 p 8; the original is *ogni Jorno faccuamo cinquenta sesanta et setanta Leguc a La catena ho apopa:* p 245 same v is a note regarding these words and giving the views of several as to their meaning. See below pp 323, 345–47, 351, as to measuring speed.

used to pay out astern as the ship goes in the way we pay out a log-line is not clear; but few will deny the passage shows speed was arrived at by some apparatus. It will not be forgotten that Vitruvius describes a log of days long before his own, 25 B C. Pilots estimated how fast they were going by glancing at the water alongside and French and Spanish seamen did not use the simple log regularly until after the English: Fournier who wrote 1667 says,[8] " The *estime* is the judgment that the pilot has made of the place where the vessel has arrived of the number of leagues she has made from such a point." Just beyond he refers to Vitruvius' wheel for measuring speed and adds, " Since some years the English use in practice an analogous means: " then immediately he describes the simple log as we know it.[9]

In the note in Robertson's Magellan mentioned in note 3d above it appears linguists who have examined Pigafetta's phrase about the *catena* believe the ship had at after end of the flare of her bow, at a place aft of which the side is nearly straight to the stern, a short beam projecting— or perhaps laid within-board, at right-angles to the keel. It would be about where the cat-head of a modern ship comes but not so massive and strong, unless intended to carry the anchor. The linguists believe pilots watched how long objects in the water were in passing from opposite this mark or projection to the stern. Can it be that such projections gave the name to the *cat-head* at which anchors are carried? If catena was in process of time changed to cat-head it still would remain to show why the projection was called catena, chain.

SPAIN TAKES STEPS TO IMPROVE RECKONINGS AND CHARTS.

The King of Spain made rules about reckonings at sea and chart-making: he issued Jan 3, 1503, " Orders for the Establishment and Government of the Casa de Contratacion; " bestowed Aug 6, 1508 the title of, " Piloto Major with Extensive Powers " on Amerigo Vespucci; and in 1527 ordered ships to keep logs.[1] The Casa Contratacion was to adjudicate matters of trading to the Indies; the Piloto Major to examine efficiency of pilots and their skill in the use of charts astrolabes and quadrants and to keep a Padron Real, a general chart posted with information to date;

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8 Hydrographie 2d ed p 549. See p 345 below as to simple log.

9 Above p 48 for Vitruvius' log; Fournier p 551 for his reference to it and description of simple log.

1 See n 2 p 554 and n 2 p 627 below; also Navarrete Colec v 2 p 285; v 3 p 299; v 1 p CXXX: p 206 above as to similar regulation in Far East.

and the logs were purposed to improve the Padron Real and ensure safety.[2] The date of the order to keep logs should be noted, for it was 100 years later that English and Dutch ships began to keep them in regular manner and there is testimonial to Spanish forehandedness in these matters written by Richard Hawkins;[3] yet ships of northern nations made quicker voyages than those of Spain and contributed a full share in the development of sea-faring.

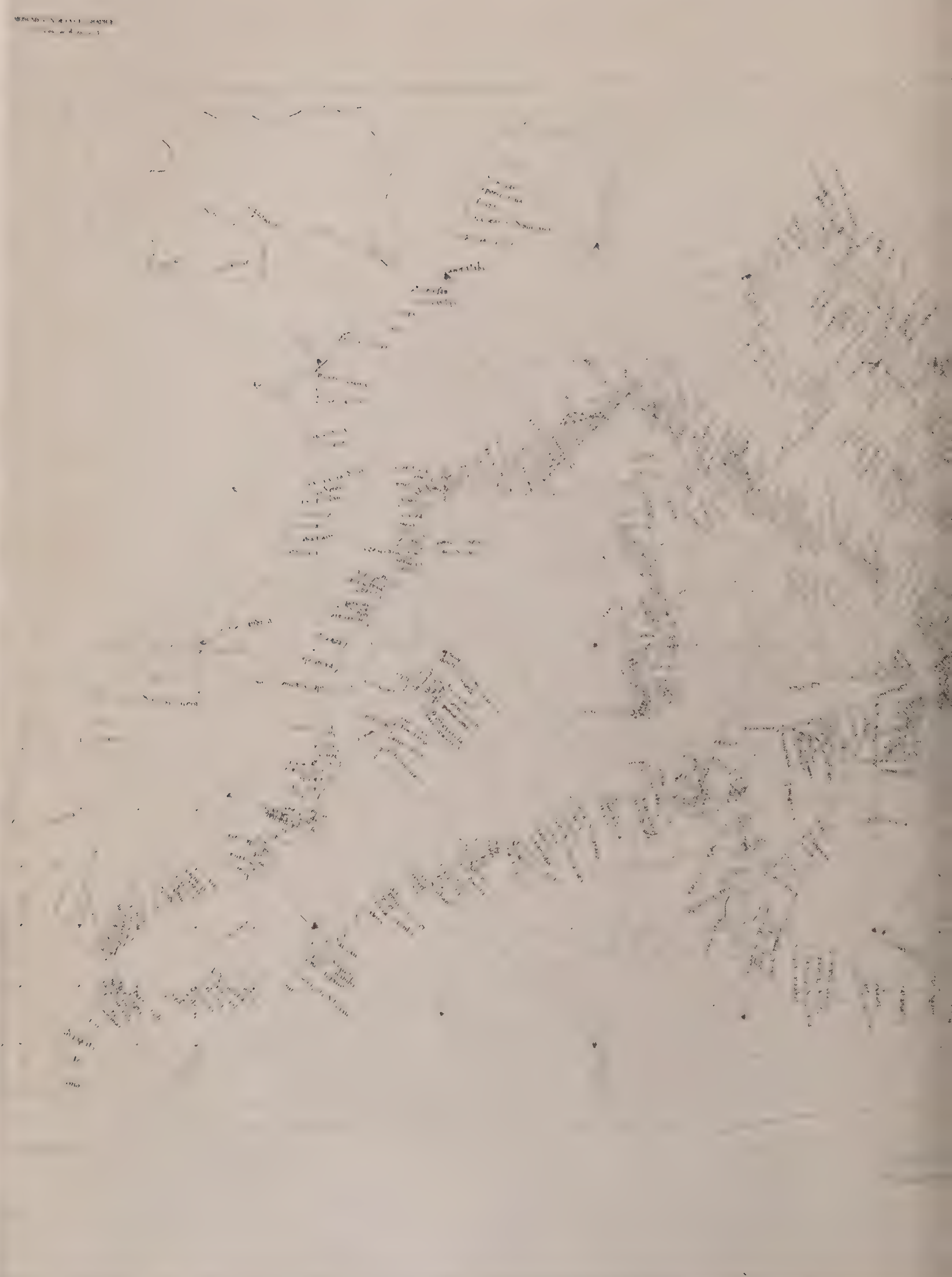
FYNES MORYSON WRITES ABOUT 1590 OF FOOD AND COOKING.

There exists a description of life at sea in Fynes Moryson's, "Itinerary Containing His Ten Years Travel" written about 1590. He says, "The Greek mariners feed of onions garlic and dried fishes. xx It was in vain to provide fresh meats because they would not suffer a fire to be made in so small a bark," and advises as to food a passenger should take, "Let him take meats agreeable to the sea in small proportions as powdered beef neat's-tongues dried and like salt meats. xx Let him often eat pomegranates quinces corianders prepared xx. To avoid the ill smells of the ship he may in summer carry red roses or the dried leaves thereof."[4] Moryson had in mind of course a round-ship making long runs at sea.

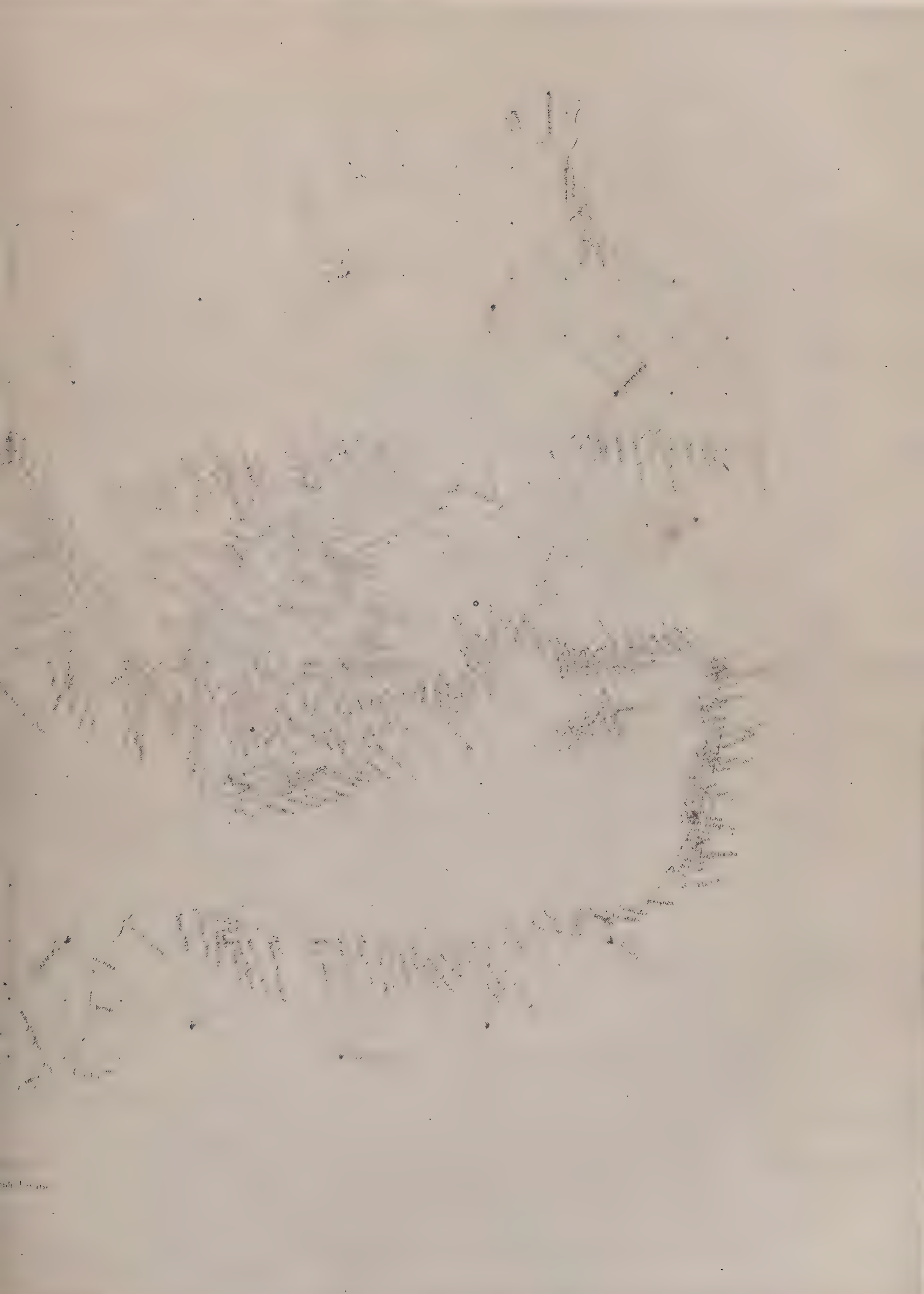
LONG VOYAGES, CHARTS.

The trans-Atlantic voyages in the north in 850 to 1450 have been noticed as well as those south, of which last that of the Genoese Doria and Vivaldi is the most interesting.[5] The islands in the Atlantic west of Africa were known to the ancients and it may be assumed were always on charts; Genoese and Catalan ships were there in the 12th and 13th centuries and those of Dieppe passed south of the Cape Verde Islands as early as 1364.[6] The Laurentian Map drawn 1351 shows the form of the whole of Africa and the islands in the Atlantic west of it, all with correctness,[7] and yet there is no record of a voyage so far south before its date. It must have been drawn from reports brought by voyagers who had visited these parts in the way we shall find others visited parts near

[2] Below pp 338 n 3, 556 n 2.
[3] Below p 354.
[4] Ed 1907 v 2 p 89; v 3 p 395.
[5] Below pp 304 and foll'g.
[6] Hist Com de France Pigeonneau v 1 p 354.
[7] Beazley Dawn Mod Geog v 3 pp 422, 439 for the map: above pp 254–5 for comment of Major regarding this map.



This is the Carte Pisane, identified by Jomard as of about 1300. In Jomard's M



eog it will be found in full size. The north is at the top and Gibraltar to left.

the great Strait before Magellan came there. There are good maps in about the day we have reached, of which the most accurate are called *portolanos*, believed to be of Italian or Catalan origin. The oldest of these is called the Carte Pisane because the geographer Jomard traced its origin to the library of a wealthy merchant of Pisa.[8] The date in which this was made has been fixed as 1300; 16 years after the Pisans were defeated by the Genoese off Meloria [9] when the war-fleet of Pisa was destroyed and her sea-commerce suffered great injury. Nordenskiold believes portolanos are of Catalan origin, that is of Barcelona the sea-port of that region, and writes,[1] "I no longer hesitate to declare that the normal portolano is a Catalan work. This view is supported not only by the many Catalan portolanos known from the beginning of the 14th to the 17th century but above all by the distance scale used xx. The unit does not correspond to any Italian or Latin unit of length but to the Spanish *legua*."

There is no doubt ships used from remote antiquity maps picturing seas they sailed in; these for long were drawn on any surface handy and the only thing we have to indicate they existed outside reasonable likelihood is the written sailing directions that have been preserved.[2] The oldest seaman's chart in the world is the Carte Pisane, for the maps of Ptolemy of many centuries earlier though well enough to freshen one's impressions would avail little in a ship. The Carte, its materials having been collected in the interval from the founding of Pisa about 600 B C until her commerce was well-nigh destroyed at Meloria in 1284 A D, is the most interesting chart in the world, but the methods by which it was drawn and how seamen used maps like it are only partly known. If one process could be discovered the other would be known.

THE CARTE PISANE; 1300.

It shows the Mediterranean and Black Seas, where Pisan and other Italian ships plied in the day; the original is 40 inches long east and west and 20 north and south, its scale being 60 miles to an inch so that a day's-run on it might reach 3 inches in length and pricking position at intervals

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8 Given full-size pl 28 Jomard's Mon de la Geog and a copy in reduced size p 518 v 3 Beazley's Dawn Mod Geog. The original is in the Paris Library: see picture here inserted.

9 Below p 469.

1 Periplus p 47.

2 Below p 320.

of some hours would be possible when the breeze was good.[3] Direction is shown by help of 2 large circles one with center west of Sardinia and the other west of Asia Minor both centers being in the sea; the circumferences of the circles are tangent in the sea south of Italy. The circumferences are divided into 16 equal arcs and from each point of division 9 radiating lines are drawn within the circumference. There are thus 16 times 9 or 144 lines; but because some are in this manner counted twice and others parallel the 144 lines give only 32 directions: so we have as many directions as are given by the full points of a modern compass and no more. There are also on the map 4 systems of lines drawn in sets in one direction and a second set at right angles, in the way section-paper is now drawn; the 4 being one on each side of the points of tangency of the 2 circles, and the other 2 separate on each circle: the sides of the small squares are 1⅛ inches, 67 miles, and there are on the map in 2 places scales where this 67 miles may be divided into 20 parts and thus 3 miles or a league may be measured on the chart. Also diagonal lines are drawn in the systems at right angles and thus changes of latitude and longitude may be derived from courses and distances or the reverse.

Direction or courses parallel to any of the 32 lines may have been established by laying off perpendicularly equal lengths in a pair of dividers. It seems parallel-rulers were not used, though the manner of drawing a line parallel to another by slipping a ruler along a triangle was understood. Thus the way of making these maps and using them was in certain respects like the ways we follow and of this there exists confirmation in the writings of 2 contemporary authors: Barros the nearly contemporary historian of early Portuguese voyages east says of the maps Da Gama found in Arabian ships in eastern waters, they were,[4] "With the bearings laid down after the manner of the Moors xx with the meridians and parallels close together xx without that multiplication of bearings of points of the compass usual on our charts which *serve as the root of the others;*"[5] and Sarmiento de Gamboa, who in 1578 had some maps to draw in Spain and found the rhumbs that is the lines above drawn

[3] Few maps of the day were on so large scale; the map in Fabri's ship was 30 miles to the inch; the map of La Cosa 200 miles to the inch: the last is a map of the world made in 1500 and is in the library in Madrid, a copy will be found in Jomard's Mon and as frontispiece v 2 Fiske's Disc America. See n 8 p 301 below; and p 293 above as to the chart in Fabri's ship.

[4] Asia, 1, 4, 6.

[5] Three Voy Gama Hakl p 138 note: see p 211 above, the Mohit chart in the East.

wrong, drew them over again. A clerk could draw the lines, but Sarmiento the pilot and cosmographer took hold when these were drawn and plotted in coast-lines, etc.[6]

These lines were used to plot coasts and cities and to find the position being called then and now *rhumbs*, which word still means in French and Spanish the same as our word *point*. By the lines and distance scales, and the first charts we have, of about the year 1300, have both, courses and distances could be resolved onboard ship into difference of latitude and longitude. The scales of charts have varied greatly; some are mentioned above and the scale of the Catalan chart a map of the world of 1375 [7] is 80 miles to an inch. Scales of direction have changed little though the number of directions recognized have altered and the names for these: on a rose of the winds drawn about 1000 A D the horizon is divided into 12 parts [8] and on a chart used by Martin Frobisher in 1576 the scheme of lines giving directions is the same as that of the Carte Pisane.[9]

THE SUPPLIES SHIPS CARRIED ABOUT 1300 A D.

We have come now to the records of the seamen themselves and these show how elaborate the furnishings of ships were. A modern author writes of the seamen of Catalonia, " In the inventories of supplies of the galleys of the King Don Pedro IV in 1359 there was ordered to be carried in each one 2 charts." [1] Advanced knowledge of sea-faring in Catalonia at date materially earlier is recorded: Alfonso the Wise King of Aragon 1252–84 in whose reign were computed the Alfonsine Tables giving astronomical data wrote in a law, " Naucheres [2] are so called because by their brains ships are guided; they are like generals onshore xx. They must be well

[6] Below p 629.

[7] Given pl 12 and foll'g Nordenskiold's Periplus: on it in East ships with 5 masts are shown bearing witness to the large size of ships: below p 302 for this map and picture of one of its sheets.

[8] Santarem Atlas pl 78. Homer names 4 winds; the Tower of the Winds built in Athens 150 B C shows 8, called Boreas Cæcias Apeliotes Eurus Notus Lips Zephyrus Sciron; Bunbury Anc Geog v 1 p 611.

[9] See pl 9, The Silver Map, Christy. The " Silver Map of the World " is the shape and 1½ times the diameter of a silver dollar; it shows the world and on it a track said to be that of Drake around the world is plotted. It is in the British Museum: below p 352 for Frobisher's map and examination of lines on it.

[1] Disertacion sobre Hist de Nautica Navarrete p 94. Peter IV was King of Aragon and Catalonia 1336–87. On the same page we read that King Don Martin who died 1410 had in his library treatises on Navigating Charts Ships and The Regulation of the Sea, all in the Catalan language.

[2] Ship-master, pilot.

informed and must know the winds their changes and all other seamanship:" in another law he says, "The astrolabe marine charts and mariner's compass are necessary to guide the ship at sea as well in bad as in good weather."[3] Raimund Lull a Catalonian of the day of Alfonso who dwelt in Majorca wrote a book called *Arte de Navegar* Art of Navigation perhaps the first of its character: it treats of instruments for taking observations, the compass, the way to reduce distances and courses to differences of latitude and longitude, etc. Lull wrote, "How do mariners measure a mile at sea xx. For this purpose they have as instruments charts compasses needles and sea-stars."[4]

THE SOUTH END OF AFRICA.

The date of the Carte Pisane is 1300 and it includes only a part of the Mediterranean world. A world-map of the same day by the Venetian Marino Sanuto has been preserved. Like the Laurentian map it shows the water-route around the south of Africa and in this place is written, "Uninhabitable because of the heat." As the latitude is 35° S this is of course an extravagance, but not an unnatural one;[5] it implies only that Sanuto in common with many believed it was so hot at the equator that men could not live there. He failed only to note that at a distance south the air grew cool again. Sanuto had hardly met any-one who had seen the Cape of Good Hope but for 2000 years before his day Arab ships had traded south of the equator east of Africa and some of these may have sighted the Cape. Only 150 years after Sanuto Fra Mauro another Venetian gives 2 writings near the Cape on his chart both indicating he believed there was a water-route around Africa: one of these is quoted above;[6] the other reads, "A short distance from these islands darkness disappears and from that point on navigation becomes easy." A recent writer quotes these words and continues, "Thus the sea-passage to the Indies is here clearly indicated and moreover we find on Mauro's chart a little beyond the Cape the following names; Maabase Soffala Chancibar (an island) and Xangibar (on the continent)."[7]

The mystery of the Cape cannot be penetrated. Herodotus says the Phenicians rounded it and we have record of other very early voyages to

[3] Navarrete cited note 2d above p 45: note the astrolabe.
[4] Nordenskiold Periplus p 16. See below p 322 as to Lull.
[5] Major's Prince Henry 1868 p 106.
[6] P 246 and p 247 as to Fra Mauro's map in general.
[7] Bensaude Astron Nautique au Portugal p 96.

it; Sanuto shows it on a map of 1300; 50 years later the Laurentian map shows it; 100 years later again Mauro shows it and adds that beyond it the voyager will no longer find darkness; meaning the darkness of high latitudes in the winter season. It remained for Bartholomew Dias 40 years after Mauro drew his map to see the great promontory and bring home report of its latitude and the courses and distances his ship ran before she raised it.

THE SUDDEN APPEARANCE OF CHARTS IN NUMBERS.

The oldest seaman's chart in the world is the Carte Pisane drawn in 1300 and preserved in the Library in Paris.[8] Contemporary or almost so are many charts which may have been like those used in ships. This could not have been a sudden change; it cannot be that before 1200 to 1300 ships carried no charts though they had been abundant for 2000 years, and then suddenly all carried them. The growth of their use was slow; the things leading to it and they are many and of different character had their beginning in pre-historic days and we should probably not recognize these if they were before us. Such small beginnings grew in a way which seems amazingly slow until in 1200 to 1300 A D the art flashes on us complete and full-powered. In years 1200 to 1300 the seaman's art suddenly rises on the gaze, being like that of modern day in essentials; only as to longitude by observation it is weak. Its history earlier than 1200 we know only in part, but must believe it was in that year ages-old and had grown straight always; there were no reversals. Of charts not long after the Carte Pisane only 2 can be noted; the Carignano of 1300 and Catalan of 1375. These show parts of the world outside the Mediterranean and indicate that Saracens and Spaniards, fighting to the death for the fair land both dwelt in, were yet working together afloat.[9] These 2 maps show that Catalan or Saracen seamen were far north on the coast of Europe and in the East in advance of those of Italy; for they drew maps of these regions before the Italians did so. The Carignano map shows the Atlantic as far as the Scandinavian peninsula and south as

[8] The copy in Jomard is *drawn,* of course from the original, and is full size: the one in Beazley and other recent books is photographed, probably from Jomard, and so small that many features cannot be made out; while details may be wrongly copied in Jomard. A large photograph of the original should be made and published. See pp 297 and 352 and foll'g for comment on lines on this map and how it was used.

[9] Hamy Etudes Hist et Geog p 30; Beazley Dawn etc v 3 p 519 as to Carignano map; and just below as to Catalan.

far as Cape Nun—not to the south of Africa; the Catalan map shows the world.

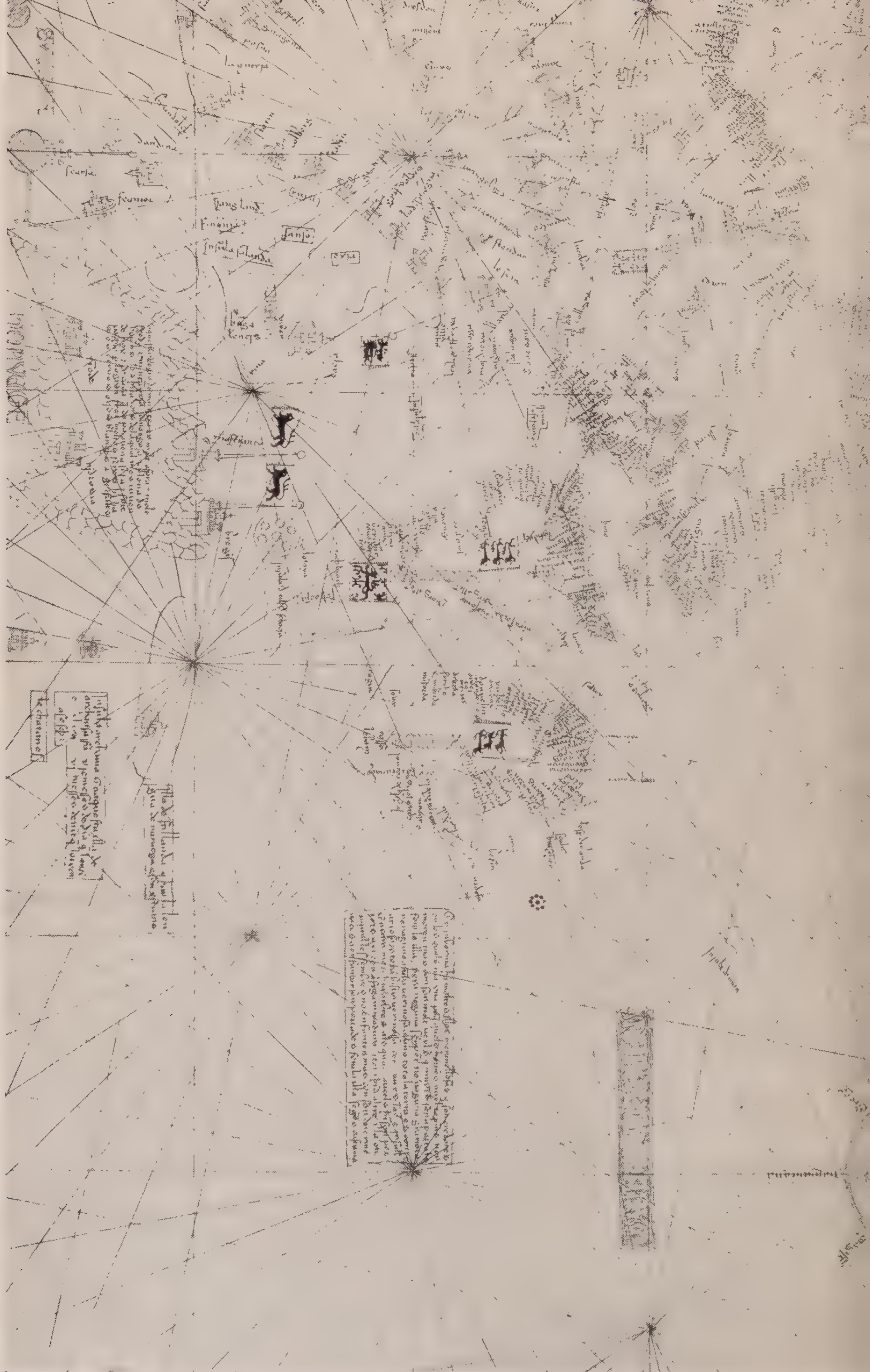
THE CATALAN ATLAS; 1375.

This is in Paris and consists of 6 maps on parchment glued to wood painted in colors and bound in a single volume; the sheets are 23 by 18 inches. The north is above; the left extends west of the Azores and the right east of China, where Pekin is at the middle of the height of the map and marked *civitas Cambaleth magni Canis Catayo.* To the left it includes west and north of Europe *Thyl Insel,* the Thule of Ptolemy, the *Ila Chatanes,* and *Insula Archania* or the Orkneys. Southward on the west coast of Africa it extends a little beyond Cape Bojador, marked Cavo de Buyetder on the map; latitude 23° N. In the East, the map does not extend far south; from the mouth of the Red Sea it shows coasts north and east but not south. It thus shows a band extending in 65° to 25° north latitude from a point in the Atlantic west of the Azores east to beyond China. It is accurate as to direction and distance. The legends on it to which we come presently are in the Catalan language; whence it appears the knowledge it embodies, which is prodigious, for thousands of places are plotted, is Catalan; that the map was made by seamen of Barcelona and Spanish Moslems belonging near by.[1]

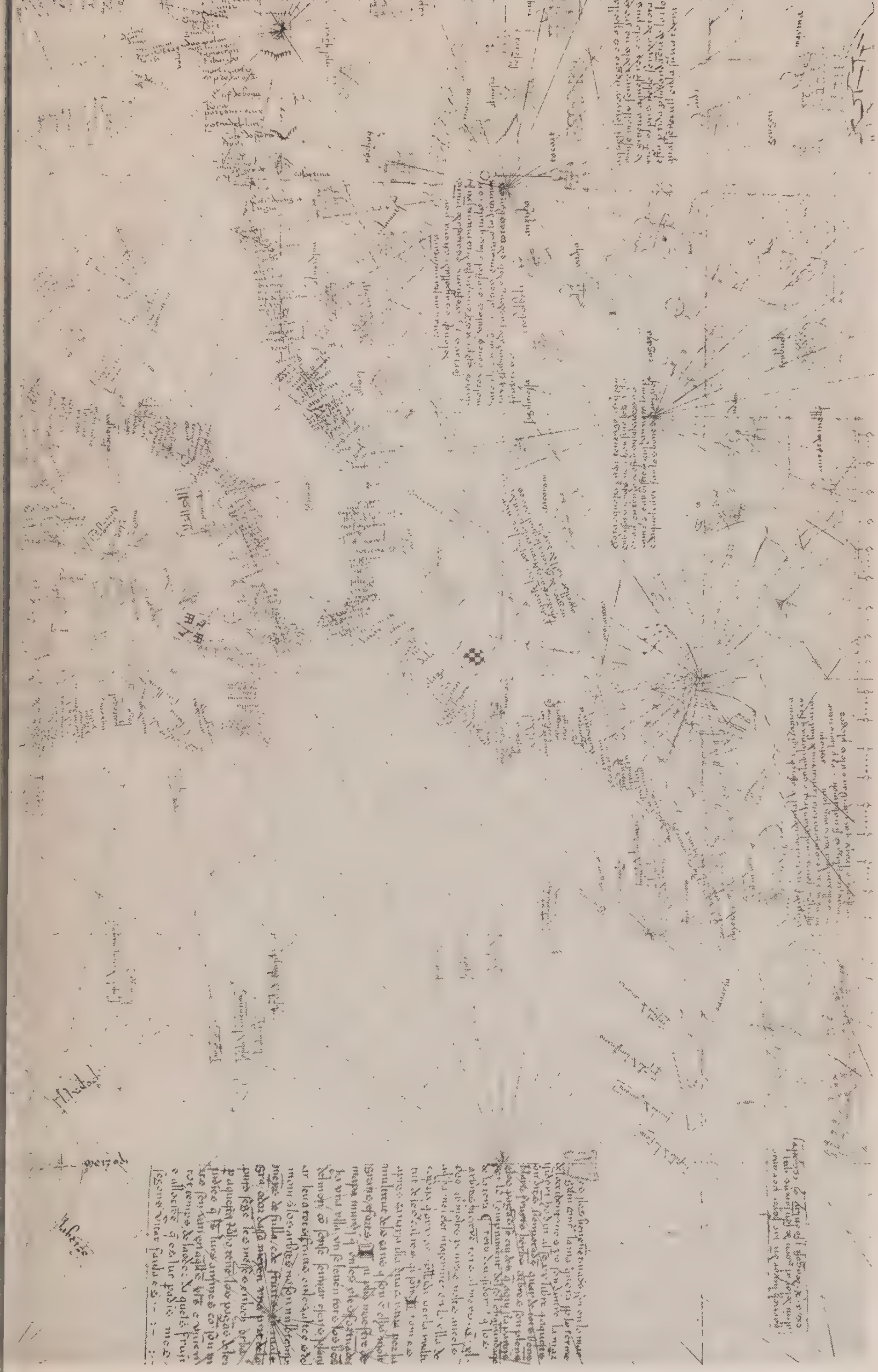
Translations of some of the legends given by Buchon and Tastu are here inserted: "The round of the earth is 180000 stadia that is 20052 miles;" following this is a dissertation on tides; a little south is written, "Ila Chatanes Insula Archania;" believed to indicate the Thule of Ptolemy (perhaps Iceland), and the Orkney and Shetland group north of Scotland. Near-by in the sea is this legend, "Here there is 6 months of day and xx 6 months of night." This is of course not correct; in the Faroe Islands 62° 15′, a little north of the Shetlands, the longest day from sunrise to sunset is 19½ hours; 22 hours of day-light; in Iceland just outside the Arctic Circle the longest days have no night and the shortest no day. Only near the pole is there one day and one night in a year.

About here is shown what we call a dumb compass; it has 32 directions as compasses have now and names for 8 winds are on it. This is I think the oldest chart showing this feature. Below in Africa is *Cavo de Buyet-*

[1] The 6 sheets are in Nordenskiold's Facsimile Atlas and in the Notices et Extr des mss de la bib du Roi t XIV 2d pt by Buchon et Tastu Paris 1841. The last is published separately and is a complete key to the map its legends and history. In both works cited the maps are the size of the originals; 23 by 18 inches.



This is one of the 6 maps composing the Catalan Atlas, of 1375: it shows the outer shore
of the legends are there. This is I think the oldest map showing what is now called a dumb
no scale given for these but measurement shows the intervals between them are irregular and a
these defining 16 points on a circumference whose center is at this point on the coast of Spain: un
but in the case of more than 1 point the number is 32: this makes the scheme of the r



ᵉpe and Africa. The 6 maps will be found in Buchou's work identified n 1 p 302: the translations
. Unlike the Carte Pisane this has lines drawn across at right angles like a modern map: there is
) miles. There are 16 lines at equal angles proceeding from a center on the north coast of Spain,
Carte Pisane this circumference is not drawn. The lines radiating from the 16 points vary in number
lines the same as on the Carte Pisane: 360° divided by 32 is 11¼°, a *point* as now called.

der, Cape Bojador, and in the sea, "The west of Affricha. Here begins Affricha that terminates at Alexandria." Just south of Bojador is a picture of the ship of the voyager Jacme Ferrer, an undecked boat with one sail and 4 men in her each as large as the boat, standing east for the coast of Africa; in the sea by the boat is written, "The ship of Jac Ferer started for the River of Gold St Lawrence day August 10, 1346." [2] The ship sailed from Majorca and was heard of no more as is told in Major's Canarian.[3]

We pass now east on the map beyond the world of the Mediterranean: at the mouth of the Red Sea, "The spices of India come to Alexandria by this sea." In the sea off the mouth of the Gulf of Persia not far from Ormuz is a ship with 5 masts and by it is written, "Know these vessels are called junks and have 90 feet of hull and at least 50 feet of freeboard. They have 4 to 6 masts xx." Close by is, "This city is called Ormuz. Here begin the Indies. To this city come vessels with 8 and 10 masts." [4] Further east beyond Ceylon are many islands and we read, "In the Sea of India are 7548 islands;" also, "The Sea of the isles of India where are the spices. In this sea navigate numerous vessels of different peoples." China is drawn a vast empire; at its N E extremity is written, "Catayo," and in the south, "Here ends Catayo." In the sea east of China is written *Mare Ocheanym.*[5]

The Catalan Atlas shows what was on charts, though the copy now existing is much too handsome to have been made for a ship—unless a King or member of the royal family was going a voyage. Its scale is small to serve well at sea but it was made and used in the same way as the Carte Pisane and Carte of Navigation of Frobisher. Unlike either, the former made 75 years before and latter 200 years after it, it has a dumb compass, but otherwise is the same; around the parts where the map is to be used are placed on a circumference a number of points equally spaced, and through these are drawn radiating lines; these extend all over the map and define direction while a scale placed at the foot or side of the map gives distances.[6]

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[2] In Catalan, "Partich l'uxer d'En Jac Ferer per anar al Riu de l'Or al gorn de Sen Lorens qui es a X de Agost y fo en l'any MCCCXLVI."

[3] Hakl p 103 and foll'g note.

[4] The heights given for junks can be correct only if we suppose them taken from the top of the elevated structures ships of the day had.

[5] As to these legends see also Bensaude Astron Nautique Portugal pp 85–92.

[6] Below p 352 the likeness of the Carte Pisane and chart of Frobisher is dwelt upon.

THE DORIA AND VIVALDI PASS GIBRALTAR GOING TO INDIA IN 1291.

Of voyages south of Gibraltar in years 1200–1400 none is of so great interest as the attempt of Doria and Vivaldi to reach the East by way of the Strait of Gibraltar and the south. It was a great event, a gallant effort to reach the East just effectually shut off; for 1291 is the year in which the Saracens captured Acre and Jerusalem finally. Thenceforth Christians should not go to the East.

The story like that of the voyage of the Zenos to America 100 years later [7] is not without the enticement of mystery. It was frequently alluded to in and near its own day and has been commented on by many modern students, of whom D'Avezac a well-known French geographer is most to the point giving the Latin and a translation of what he calls the *texte décisif*. This is an account written in 1294 by Jacques Doria as follows: "1291; In the same year Thedise d'Oria Hugolin de Vivaldo and his brother with other citizens of Genoa commenced the execution of a certain voyage that no-one until that moment had thought of making. For they equipped in the most perfect manner 2 galleys, and having provided them with food water and other necessary things they sent them in the month of May without the Strait of Septa (Gibraltar) in order they might go by the ocean sea to the coasts of India and bring from there merchandize at a profit. The 2 brothers Vivaldi named went in person as well as 2 priests. This caused astonishment not only with those who saw it but with those who heard it talked of. After they had passed the place people call Gozora no certain news has come from them. May God guard them and bring them safe to their homes." [8]

Gozora's whereabouts is uncertain; Pertz places it between 29° and 12° N latitude and states that Usodimare a man who found descendants of the voyagers near Menim in Africa in the year 1455 was at the time, "Within one day's march of the equator where in July the day was 12½ hours long and the night 11½;" this would be nearer the equator than 12° N, where the distance from it is more than 700 miles. It is stated by

[7] Above p 277: see pp 201 and foll'g for attempt of Eudoxus about 120 B C to round Africa.

[8] Nouv Ann des Voyages de Geog de Hist et de Archeologie 1859 v 3 serie 6 5th year p 286: D'Avezac's article is pp 273–89 and is called L'Expedition Genoise des Freres Vivaldi à la Decouverte de la Route Maritime des Indes Orientales au 13 ieme Siecle. Immediately preceding in the volume is a French trans of an article by Pertz regarding the voyage agreeing with D'Avezac. Pertz' article is called La Plus Ancienne Tentative pour Arriver à la Decouverte de la Route aux Indes Orientales en l'Année 1291. The Nouv Ann des Voyages is in the N Y Pub Lib but not commonly found.

Pertz that some of the day believed the ships rounded the Cape and the men perished in what we call Abyssinia.[9] If Africa was in truth rounded or if natives had said their own craft went around it to trade and such reports had come to Europe there is no reason to wonder how Sanuto's map 1300 and Laurentian 1351 came to show the Cape of Good Hope.

It remains to tell the fate of the men of the expedition. They perished probably but perhaps lived their lives out in a strange land, for such has been the fate more than once of travellers who penetrated far, but the record tells of no return. The only fragment regarding them that reached Europe is in a letter written by one Usodimare Dec 16 1455 to creditors at Genoa telling of a, "City of Ethiopia called Menim:" he says, "I met there a descendant of those Genoese of those I believe of the galley of Vivaldi lost 170 years earlier who told me xx that except himself there were no more there of his race."[1] The voyage was undertaken and the ships equipped by private enterprise. It was not like many great voyages, those recounted by Herodotus, those of Prince Henry the Navigator's day, of Dias Da Gama Magellan and Columbus, aided by government. Only this voyage and that of Eudoxus of Cyzicus who set out to round Africa 1400 years before,[2] were private ventures and above is all we know of the Doria voyage with one small exception, to be mentioned immediately. The voyage preceded by 125 years the beginning of the advance southward of the Portuguese.

In about 1350 a Franciscan monk a Spaniard whose name is not known wrote a work [3] which reads in part, "In the year 1281 there sailed

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9 See Pertz' article cited note preceding pp 269–271 as to position of Gozora; p 261 and text just below as to Usodimare; p 265 as to ships having rounded Africa.

1 See a review of Major's Life Prince Henry by Codine in Bull de Soc de Geog 6th serie V 1873 pp 412–18. There is also in this review the words of Petro d' Abano 1472; Ubert Folieta 1528; and Agostino Giustiniano 1537, regarding the voyage: the last is in Italian and reads, "In the year 1290; In this year Thedisio d'Oria and Ugolino di Vivaldo xx attempted a new and unusual voyage; xx to go to India by the West xx. They went by the Strait of Gibraltar and navigated towards India xx." The other passages are in Latin and agree with the words of Giustiniano. See Major Life Prince Henry pp 100–117 ed 1868 regarding this voyage.

2 Above p 201.

3 El Libro del Conoscimiento de Todos Los Reinos Tierras y Senorios que son por el Mundo que Escribio un Franciscano Espanol á Mediodias del Siglo XIV y ahora se Publica por Primera Vez con Notas de Marcos Jimenez de la Espada. The original is in the Boletin de Soc Geog Madrid II 1877: an Eng translation is in Hakl where called Book of the Knowledge of all the Kingdoms Lands Lordships etc. The Spanish copy contains things of interest not in the trans and vice versa.

from the port of Genoa 2 galleys under command of D Vadino and Guido de Vivaldo with intention of going by the East (por Levante) to the parts of India, which galleys navigated much. But when they were in the Sea of Guinea one of them got on shore so that it could no longer proceed on the voyage. The other however continued through this sea to a city of Ethiopia named Menam,[4] whose inhabitants who were Christians of the said Prester John,[5] took possession of the crews, reducing them to such close captivity that none could return to his country. The city of Menam is in the sea near the river Sion."

PORTOLAN MAPS.

As respects these [6] it is to be added that most of those now existing which were found in libraries and convents are far too costly to have been intended to be used in ships [7] and their scale is so small they could have been of little service there. As respects so-called maps of years before that of the portolanos, of which a number have been preserved, they are not maps at all but pictures of religious character; they do not show direction of places from one another nor distances between them. Making maps which are correct in east and west direction was of later growth than generally realized; the maps of Sansom of 1668 show the Mediterranean with east-and-west length nearly $^1/_3$ too great and the mouth of the Ganges is 25° too far east.[8] Not until longitude could be found easily and accurately about 1750 were positions determined: correct maps followed in time.

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[4] See articles of Pertz and d'Avezac n 8 p 304; ns 1 and 9 p 305.

[5] An imaginary person, a priest-king usually placed in Asia believed to be conqueror of heathen peoples; the fiction had influence in mediæval days and was widely believed.

[6] Anthiaume Cartes Mar dans l'Antiquite in Bull de Geog Hist et Descriptive 1912 p 355 writes, "Charts or marine itineraries figured were called in the Mid Age portulans. The expl texts or written mar itineraries were called in antiquity *periples;* in the Mid Age *portulans,* then *routiers.* Unhappily the greater part of the graphic repr which without doubt accompanied all works are lost." The author adds in a note, "The word portulan occurs first on a Neopolitan chart of 1285. Today this name is applied to an atlas or collection of marine charts." See pp 320 and foll'g below as to sea itineraries.

[7] Below pp 321 and foll'g for an inexpensive chart in a ship in 1294.

[8] Gosselin Geog des Grecs Analysée p 148: p 39 is stated, "The Ephemerides of 1784 xx contain only excepting France 565 positions determined in lat and long in Europe Asia and Africa, and not ¼ of these were by ast observations that can be quoted." See p 627 below for earliest determination of lats and longs of places far apart by observation.

FINDING POSITION AT SEA IN EUROPEAN WATERS IN YEARS 500 TO 1500.

The principal instrument in keeping position is the compass;[9] they were not much used in Europe before 1100 and by 1300 the needle stood balanced on a friction-less point carried a light circle whereon was marked the points of the compass and was provided with a lubber's-mark showing the ship's head. We do not know when it was learned how to make good and strong permanent magnets. As however when we hear first of the compass we hear also of bringing a natural lode-stone near the needle and moving it appropriately to affect the latter and then taking the lode-stone away while a short time after we hear little of this, it may be assumed it was learned steel once magnetized will remain so; thus before 1300 compasses were in form like those now used. But it was long before they indicated direction well in a heavy sea-way and early navigators refer to compasses in terms that would not be used now: for instance (1) Frobisher in his Voyage in Search of a Passage to Cathaia by the Northwest in 1576 states how to make both floating and pivoted compasses and speaking of a magnes says, " A piece of steel being but touched with the aforesaid magnes xx;" (2) Baffin about 1620 refers to, " Our common sailing compass," and says it is, " Touched $5\frac{1}{2}^\circ$ eastward and the variation is westward." Apparently they moved the circle on the needle as the variation changed; (3) Captain Thomas James wrote In Search of a Northwest passage in 1632; giving Names of Several Instruments I Provided and Brought for This Voyage, and among these is, "Four special needles of six inches diameter and touched curiously with the best lodestone in England," and, " A lode-stone to refresh any of these if occasion were, whose poles were marked for fear of mistaking."[1] In days not far from our own the works of Captain Basil Hall of the British Navy afford interesting reading regarding poor compasses uncertainty of longitudes etc.[2]

Other instruments for finding position were used in early days; for ships of the Mediterranean, of Cadiz Barcelona Marseilles Genoa Venice and other cities in Italy and Constantinople, though harried by Saracen pirates, never abandoned the sea. Their shipping existed long before the conquests of the Mahometans 650 to 700, and kept the sea in spite of

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[9] Above pp 263 and foll'g as to compass.

[1] See in Hakl, (1) Frobisher's Voyage p 29; (2) Baffin's Voyage p 44; (3) Voyage Capt Luke Fox and Thomas James.

[2] Voy and Travels, The Midshipman, The Lieutenant and Commander.

sinkings and burnings murder and destruction it is difficult to conceive; and in the same period as we have seen Irish and Norse ships were making long voyages in the North. The seamen of all countries must have known what the Arabs knew and these have left records showing they could guide ships earlier than 800. The records show the Arabs [3] made and used astrolabes, tables containing data necessary in making calculations, made observations for latitude and azimuth, brought position forward by courses and distances working these into northings and southings eastings and westings, and understood what we call time-sights, altitudes to determine the hour of the day; but since they could not carry with them the hour of the day at home as we now do it is not apparent what use they would make of this unless to determine the hour of occultation or meridian passage of a celestial body. If the hour at home at which this would occur had been calculated in advance by astronomers and the ship carried record of this, longitude could be determined. For the ordinary business of the ship sand-glasses or a glance at the positions of the heavenly bodies sufficed. To determine the speed it is necessary to measure time and this was probably done by that very ancient appliance the sand-glass, but sometimes handier means requiring no apparatus were employed.[1] By the beginning of the Great Ocean Voyages we read of all these including attempts to find longitude by celestial phenomena. The last failed, not because seamen did not understand the calculations involved but because the hour at home could not be correctly predicted in consequence of want of knowledge of the movements of heavenly bodies.

It requires some hardihood to say the instruments for navigating and processes for using them were elaborated in Greek days and before the Christian Era and yet if one attempts to fix a date there is much to show this is the correct one and nothing to show it is not. The absence of mention that seamen employed existing aids is probably due to want of intelligence in historians, for until the late Middle Ages there is no word about how ships were guided in the countless voyages they were making; no chart is referred to even—though there must have been thousands in ships. When seamen began to write about 1400 a finished art of navigation is exhibited. It must have been in preparation—from what date? We can conclude only that the foundations of sea-faring were laid in days pre-historic, much elaborated by the Greeks, acquired from them by the

[3] See above pp 56, 58, 63, 237, 238.

[4] Below p 345.

Anglo-Saxon ships of 750 A D: from pl 16 v 1 Strutt's Chron England; see also p 227 v 2 for other similar ships. These are very like Chinese and Japanese junks of today.

This is the picture at p 178 the Raccolta Columbiana showing the sailing of Columbus: in the Raccolta it bears legend, "The sailing of Columbus; the nao Santa Maria precedes the two caravels."

Arabs, and by this wonderful and adventurous people carried by the year 800 to every quarter of the earth from the Azores to the Spice Islands in the East.

SHIPS AND THEIR RIG.

Before the Crusades round-ships of the West had only one mast and one sail on this and the small vessels were steered by oars over the quarter, but such they were in general only for large vessels used more masts and sails and were steered by hinged rudders. The details of ship-fitting cannot be entered on here for the variety is very great. A list of works where ship building and masting are treated is inserted [5] from which may be learned something of how ships have been built and rigged: in the present work will be noticed only those features which affect usefulness. Charnock gives a picture of a modern Chinese junk very like Anglo-Saxon ships of 700 A D shown in Strutt.[6] Even now civilized people use similar craft: in the Introduction to his Heimskringla Laing writes,[7] "The large open vessels which at present carry dried fish from the Lofoden Islands to Bergen which although open for the sake of stowage are of a size to carry masts 40 feet long which are struck by the crew when not under sail there being no standing rigging and only one large square sail." The run is 600 miles in a region of fogs and gales along a bold coast. The 3 ships which went Columbus' first voyage are said to be shown by him in the margin of his journal; [8] 2 have a nearly upright mast at the bow carrying one square sail, a longer mast amidships carrying 2 square sails, course and topsail, and a mast aft carrying one lateen-sail, fore and aft. The other ship has no spar at the bow but 2 vertical masts with single lateen-sail on each:

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[5] The 2 books of Admiral Paris called Musee Mar du Louvre and Essai sur la Constr Nav etc; both illustrated: the last is not in all libraries but is in the N Y Public. From it one can realize the variety of sails used. See also Jal Arch Nav and Glossaire Nautique; Charnock's Hist Mar Architecture, 1801; Chronicle of England Strutt 1779; Steinitz The Ship Its Origin and Progress, 1849; Lindsay Hist Merch Shipping, 1874; Cotterill and Little Ships and Sailors. Jal and Strutt are perhaps the best. Nicolas Hist Roy Navy is excellent; herein v 1 p 100 a fleet of 100 ships arrived in Syria from England 1107; p 223, cabins in a ship for the King and Queen are "Wainscotted;" p 339, "Two Venetian galleys laden with merchandize arrive in England in 1323;" p 370, author places adoption of modern rudders in England in 1350; v 2 p 180 the compass in English ships.

[6] Mar Arch v 3 p 292; Chron England v 2 pp 227, 284: a picture of one of these will be found here.

[7] P 137.

[8] Jour Columbus Hakl p IV; see picture here inserted.

the rudders of all are hinged amidships.[9] An authentic picture of ships with one mast and one sail on this is found on a letter by Vespucci in 1505.[1]

A quotation from Fuller's Worthies in Charnock shows ways in British men-of-war in about 1600 and the fear of fire in those days, "After 8 o'clock," it reads, [2] "None save the captain lieutenant and master may presume to burn a candle. No smoking of tobacco save for the privileged aforesaid at any time but in one particular place in the ship and that over a tub of water. Preaching they have had lately twice a week praying twice a day but my intelligence could never discover that the Lord's Supper for some years was administered onboard of any ship an omission which I hope will be hereafter amended." The Venetian voyager Cadamosto who died 1480 wrote, "The Portuguese caravel is the best vessel that goes upon the sea with sails," [3] and the type long maintained good repute for Pantero Pantera commends it in his Armata Navale written 200 years after Cadamosto.

COLUMBUS' SHIPS.

The fore-and-aft rigged ships of Columbus' fleet were called caravels; the ship he crossed in himself was the Santa Maria a square-rigger.[4] The names of the fore-and-afters were Pinta and Nina. In the copy of Columbus' Journal in Navarrete's Coleccian we read of his *tres carabelas;* also of *la carabela Pinta* and *la carabela Nina.* The other ship Santa

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9 Jal Arch Nav v 2 p 227: he writes p 154, "La *mestre* was the largest sail of the *nef;* it was suspended to the single mast in about the center of the deck xx. A bonnet a large band of sail-cloth could be fastened to the foot of the sail, xx this could be diminished by reefs." Figs p 159 this v show nefs thus rigged in 1417 and 1467; figs pp 190–1 show nefs of about 1550 with 3 masts and courses and topsails; figs p 437 show rudders in mediæval days: all these consist of 1 or 2 oars on the quarter not rudders centrally hung; but Herodotus v 2 p 86 trans Belœ says of ships of Egypt, "They have one rudder which goes through the keel of the vessel." For scale drawings showing modern views of Columbus' ships see Raccolta dei Documentie Studio xx pub 4th Centenary etc ed Alberto d' Albertis pt 4 V 1 p 94 and foll'g 1893.

1 Fiske Disc Amer V 2 p 168: the picture is given.

2 P 301 v 2 Charnock's Hist Mar Arch cited n 5 p 649: Fuller died 1661. See also below; p 523; about 1700 none may smoke in a galley but may in the boat astern.

3 Major Prince Henry p 309.

4 Journ Columbus Hakl p 17 note: Oviedo a cotemporary says Columbus' ship was the Santa Maria. In the Spanish ed of the History of Columbus by his son Ferdinand p 13 is written, "La capitana in which he went was called Santa Maria another the Pinta another the Nina, which was *latina* (f and aft rigged). Provided with all necessaries the vessels with 90 men xx:" it is a thousand pities we do not know the supply of water and food Columbus took.

Maria afterwards grounded and lost Columbus does not call by name; but we have her name from contemporary writers. Columbus calls the Santa Maria a *nao* a ship but does not use this name for the other two; he writes Oct 24 in his journal, "I carried all my sails on the nao, the mainsail with its 2 bonnets [5] foresail spritsail mizzen main topsail and boat's-sail on the poop." If the pictures said to be drawn by Columbus were so drawn, with these and the passage cited we understand what the ships were.

Columbus crossed the Atlantic in the trade-wind and went north into the west winds to return which indicates he realized the nature and situation of these great currents: the matter of the rig of his ships supplies confirmation of this; when anchored in the Canaries on his way out on the first voyage he wrote, "They rigged the Pinta square for she was fore-and-aft." [6] Fore-and-aft sails are inconvenient with stern wind, dangerous if it is strong and probably this was the reason the vessel was changed to square-rig before the long voyage in the trade-wind: the fact that Columbus went out in the trade and steered north into the westerly winds on the way home is stronger proof the winds were understood.[7]

DA GAMA'S SHIPS.

The ships of Da Gama are shown in Ravenstein's First Voyage of Da Gama.[8] He had 4, 2 of them *naos*, ships, one a caravel and the other a store-ship. Of the last Ravenstein says.[9] "She was of considerable size, xx Castanheda credits her with 200 tons. She may have been a so-called *carabela redonda* that is a caravel which carried square sails on the main and fore masts and triangular ones on the mizzen." She would then be rigged like the nao in Columbus' fleet. Caravels were very like modern schooners and worked to windward well; to make a long run with fair wind they took aboard a square yard and sail: they were inferior to modern schooners in that when they tacked it was necessary to lower the sail part way, dip the yard to the other side of the mast and hoist again for the sail had to be on the lee side of the mast: the account of this by an eye-witness will be found p 500 below.

5 Note the 2.

6 Journ Navar Colec v 1 p 5: his words are, *"Hicieron la Pinta redonda porque era latina."*

7 See La Tavola di Bronzo Banchero for track-chart of Columbus' voyages; also Winsor Narr & Crit Hist p 196.

8 P 160. P 152 is large illustration of Da Gama's ship the Sao Gabriel and p 158 a caravel with 2 masts and 1 fore-and-aft sail on each.

9 P 158.

OTHER EARLY SHIPS.

A number of mediæval ships are shown in Demay and De Bry.[1] In the first ships of 1250 to 1450 depicted on coins and seals are shown, while those in De Bry are from 1550 to 1630. Vessels earlier than 1400 have one mast and one sail which when furled is on the yard at the mast-head; some later ships show points on the sails for reefing like those we use. Steering is by oars on the starboard quarter except in a single case: a ship of 1335 on the seal of Damme has a centrally hinged rudder. Nearly all have castles at bow and stern and some have small ones at the mast-head. In the seal of St Sebastian only 1335 have the shrouds ratlins for furlers to go aloft: yet sails were furled aloft in early day. Queen Hatshepsut's ships of 1500 B C show sails furled on the yard and the yard down,[x] still the sail may have been furled before the yard was lowered: other early Egyptian ships show men aloft on the yards. A round-ship on Trajan's Column [y] 100 A D has her single sail brailed up to the yard aloft and hanging loose and unfurled. One ship in De Bry shows a small boat fast to a whale; it is of Biarritz and of 1351. There are works by Captain Duro about Spanish ships and their operations written not long since which repay examination.[2]

Naos of Europe until about 1400 had usually one mast and one yard with square sail on this. Probably the ships that went and came between the old country and the Norse settlements in America for 400 years preceding 1400 were thus rigged.[3] After 1400 fewer ships with only one mast are found: on the Spanish maps of Diego Ribero 1529 several ships are shown all with more than one mast; some with 3, 2 rigged square with topsails and courses on each and one fore-and-aft. In these vessels the main course has 2 bonnets laced to its foot and the fore-course one. These

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1 Costumes Moy Age d'apres les Sceaux, Demay: there are many eds of De Bry; perhaps the best is India Orientalis 3 vs in German. See also Lindsay Hist Merch Shipping v 1.

x Above p 28.

y Pl 117 in ed of Rothschild Frœhner Paris 1872 4 vs.

2 Armada Invencible, Disquisiciones Nauticas, Armada Espanola; another has for title, Cervantes, Marino, Demonstracion, etc: Navarrete wrote to show Cervantes was a soldier and Duro shows he was a sailor. He was onboard the galley Marquesa de Juan Andrea at Lepanto 1571. P 12 Duro shows that in Cervantes' time there was no distinction between forces on sea and land and from p 9 it appears this was the case until reign of Philip V 1700. Pp 32–35 show Cervantes was familiar with what pilots and cosmographers of his day knew.

3 When Queen Margaret of Norway and Denmark made trade to the settlements a crown monopoly in about 1400 decay came and traffic ceased; Fiske Disc America v 1 pp 221–26.

bonnets are of great interest: when taken off to reduce sail, was the yard left where it was when the whole sail was set, leaving space for seas coming aboard to pass or was it lowered and the foot of the sail brought where it was before? There is nothing in contemporary writings to show certainly which was done but most likely room was left for seas to pass for ships of the day took green water onboard often. The yards were lowered and hove up at times; being *parrelled* to the mast as now by rings of hide to withstand strain and friction. In the vessels on Ribero's maps there are huge sprit-sails under the bow-sprits as big as the main-topsail, no sails above topsails and no jibs.[4]

SHIPS WERE AT EARLY DATE IN SEAS EAST OF AFRICA.

The work of Grandidier referred to in the preceding note is of much interest for all islands are interesting and none more than Madagascar, for many centuries perhaps thousands of years the outpost and crossing of the way of ships. It is the furthest west of those great seafarers in ages long gone, the Polynesians, the furthest south of the Arabs in a later day, and was the crossing point of Da Gama. It was known to the world of Europe 15 centuries before Da Gama raised it, for Greek seamen visited it about the beginning of the Christian Era it having been known to those of Arabia Persia and India long before.[5] Ptolemy the Geographer taking information from Greek voyagers down the east coast of Africa and from Marinus of Tyre, whose knowledge came from logs of Arab and Phenician seamen, called the island Menuthias. About 900 A D Macoudi visited it, Arabian map-makers show it and Edrisi geographer to King Roger in Sicily about 1150; so great was its fame that Marco Polo alludes to it 200 years after Edrisi's time and 200 before Da Gama saw it.

SHIPS WITH SEVERAL MASTS AND SEVERAL SAILS ON EACH; TOPGALLANT-SAILS.

As time went on round-ships changed their single deep big-bellied sail carried on the yard of a single mast for numerous sails carried one above the other on several masts; a simple change greatly increasing efficiency,

[4] Nordenskiold Facsimile Atlas pls 48, 49, for these maps. See Grandidier Hist Madagascar v 1 for other maps on which ships are drawn; the last of these, Gastaldo's 1560, shows in the Indian Ocean 2 Arab war-ships, long straight on the water lean with oars and one flat-standing lateen sail, and one Portuguese or Spanish nef or nao, ship, bluff and short with 2 masts and widely bellying sails. Nowhere is the contrast between appearance of long- and round-ships better shown.

[5] Grandidier v cited p 2. Bunbury Hist Anc Geog v 2 pp 452, 611. Grandidier published also a Coll des Œuvres Anc Concer Madagascar containing orig documents.

for it became easier to reduce or make sail and held sails flatter enabling the ship to look higher. In the day of Dias Columbus and Magellan ships carried topsails above the courses [6] and we hear first of the sail above the topsail the topgallant sail in a voyage west from Callao Peru of Pedro Fernandez de Quiros in 1605 to colonize the Solomon Islands; in the log of Zeza chief pilot. In this on Jan 14, 1606 was entered,[7] "This day we set a main topgallant sail another name for which is sail over the topsail. The Almiranta made sails at yard-arms and another invention of a sail astern." Here are topgallant sails studding sails and spanker or driver.

THE VOYAGE OF QUIROS WEST FROM PERU IN 1605.

Other interesting circumstances are narrated by Quiros. He failed to find the Solomons, which had been discovered by Mendana sailing from Callao 1568 in which voyage Quiros had been pilot, Mendana commander. Quiros explains why he failed and though impossible to understand this is interesting. Before sailing from Callao Quiros, "Made many charts from information gathered on the preceding voyage. He was ordered not to show more land on them than the coast of Peru from Arica to Payta xx and 1500 leagues to the west of Lima; xx the extreme distance in longitude of the islands of which he was going in search." Callao is south of the Solomons and the difference in longitude is 123°, more than 2000 leagues or 6000 miles, so the distance run west in the voyage in 1568 had been recorded. The reason Quiros was to show on the charts nothing of the Solomons was because the purpose of the voyage was to discover new lands for the benefit of the few, rich ones being hoped for. He writes being near an island, "The Chief Pilot eased off the fore-sheet (no large ships used jibs) put the helm down and the ship went around." When they despaired of finding the Solomons (8° S 160 E from Greenwich) he writes regarding the best way to return to Peru that a pilot Galleygo, "Reported it was better to take a northern route in returning to Peru because it was difficult to find favorable winds further south. Few pilots would give this reason because the usual winds outside the tropics in the same latitude are much the same on the north as on the south side." This was written in 1596.

[6] The Victoria Magellan's ship is shown on the cover of Pub Hakl Society and p 210 Guillemard's Magellan.

[7] Below p 619. It would be of interest if copy of the orig Spanish were at hand to look up the words for the technical expressions. See again as to topgallant sails p 619.

The ships however went north to the Philippines to reach the westerly wind of the northern hemisphere. We should not too hastily condemn them; it was nearly 200 years after that a ship first crossed the stretch between Australia and Cape Horn, it being done by Cook. So Quiros steered north across 50° of latitude to reach the west wind of the north: as the ships approached the Philippines, the hull and rigging in crazy state men dying of hunger and thirst and those alive barely able to stand from the dreaded scurvy, Quiros writes p 116, "The Chief Pilot navigated only by information and without a chart seeking for Cape Espiritu Santo the first land of the Philippines." When they made land he writes, "The Chief Pilot said, xx 'I never saw the land in my life until now nor am I a sorcerer. I came in search of the Cape Espiritu Santo. It ought to be here within 2 leagues more or less.'" It was very close; they had been guided by information obtained in islands passed and could have had no good chart including the Philippines and Solomon Islands. They reached harbor shortly and "During 3 days and nights the galley fire was never put out." [8] The crew were starved because of small rations served out on account of not knowing how long the ship would be making the voyage and of niggardliness and inhumanity of those aboard who had purchased and were dispensing food. Insufficient food and water and filthiness of ships had much to do with the frightful mortality in long voyages, many even of those who came through never recovering health. James Cook was the first to sweep this away.

THE PORTUGUESE AND SPANISH FOUND THE GREAT WIND COURSES AND CURRENTS QUICKLY.

Long before the day of Quiros the great winds and currents of the oceans were known. Dias more than 200 years earlier discovered and put into practice the correct way of going out and back from the Cape of Good Hope; [9] Columbus knew the trade and westerly winds of the northern hemisphere, probably known before his day, and Quiros tells of the discovery of a wind and consequent sailing route. He says about 1595,[1] "There was a pilot named Juan Fernandez who discovered the track from Lima to Chile by going to the westward which till then had

[8] For words quoted see Quiros' book cited note next above, pp 136–44, 10, 113, 142, 116, 120.

[9] Below pp 535, 537.

[1] P 526 v 2.

been made with much difficulty as they kept along the shore where the southerly winds almost constantly prevail xx." A south wind blows all the year up the coast of South America from below Valparaiso to beyond Payta. The island Juan Fernandez off Valparaiso is called after this pilot; but is often called Robinson Crusoe's island, as that renowned person was cast away on it.

Quiros though he could not find the Solomons and wrote a fearful story telling why shows his countrymen had staked out the Pacific and its trade-routes before 1600. He gives important information of another character, recording that in 1595 or '96, " He ordered a brick oven to be built over one of the hearths in order to make sweet water from sea water with a copper instrument he had with him by means of distillation. This made 2 or 3 jars-full every day very good and wholesome." This was not long after leaving Callao; later they caught rain water as, " The machine could not produce water for the want of fuel, we had come to an end of it and none for cooking." [2] At the same date Richard Hawkins distilled at sea; he wrote, " Although our fresh water had failed us many days xx by reason of our long navigation without touching any land and excessive drinking of the sick and diseased yet with an invention I had in my ship I easily drew out of the sea sufficient quantity of fresh water to sustain my people with little expense of fuel xx." [3]

MASTS AND SAILS OF WAR-SHIPS ABOUT 1650.

The works of Fournier and Pere Hoste [4] show almost the same sails as described in the log of Quiros though written about 150 years later: in a picture of a ship in the first work [5] are shown fore and main topgallant sails none on mizzen a mizzen topsail and lateen mizzen course; there is a sprit-sail under the bowsprit and a sprit-sail topsail above it. No fore-and-aft sails are shown except lateen mizzen course. The sterns of the ships are very high; the bows, low and thrust forward look as if intended to scoop up water. There are 2 complete rows of guns and a single gun higher and 2 lower than these and no boat showing anywhere. In Hoste's book, usually said to be the earliest systematic treatise on naval evolutions, are many pictures and the ships are like those shown by Fournier, sterns

[2] P 196 Quiros: see p 617 below.
[3] Cited again with further comment p 618 below.
[4] Hydrographie 2d ed 1667; Art des Armées Navales 1697.
[5] P 12.

high and bows low. There is in neither a fore-and-aft jib or other sail set on a stay in a large ship but small ones have these and ships shown fighting by Hoste have sprit-sails furled. They had thus in battle no sail forward of the square sails on the foremast; but they could work and tack for in an action off Plymouth Aug 26, 1652, "Ruiter twice cut the enemy's line." [6] In the life of Ruiter cited which is co-temporary lines-of-battle are shown cut; large ships have topgallant sails but furled in battle, sprit-sails and sprit-sail topsails also furled in battle, no jibs and a lateen-sail on the mizzen. The author who may have known the great commander says the English line was more than once cut in the Four Days' Battle in 1666. Hoste does not state an earlier performance of this famous evolution, the *diekplous* of Herodotus Æschylus and Phormio 2000 years before, but says of it, "The manœuvre is equally bold and delicate." [7] He did not believe his chief the Comte d' Estrees nor an admiral of the day invented it.

We leave here the subject of masting and rigging ships. By 1700 they carried topgallant sails but large vessels had no royals nor sails set on the stays. These came later; royals universal in late days were not much used until within about 100 years of the present. The same may be said of stay-sails and studding-sails though the latter must be meant by Quiros [8] writing in 1606. The handling of sails and running rigging has already been gone into; braces and lifts for yards halliards clew-lines tacks and sheets bowlines etc as now were used from early date; mention or pictures of these exist, but they might all be taken for granted for without them sails could not be used.

IMPROVEMENTS LEADING TO BETTER DESPATCH IN VOYAGES.

One way to increase freights moved is to make ships more efficient; cause them to make more voyages in the same time in safety, and in the stirring times of the Crusades details of fitting ships and making voyages

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[6] Brandt Vie de Ruiter p 19. The original Life in Dutch was printed 1687. In the N Y Public Library is copy of a letter Ruiter wrote: "A Letter from the Heer Lieutenant-Admiral De Ruiter to the States-General Giving an Account of the Late Engagement between Him and the French Fleet on the Coast of Sicily, Trans out of the Dutch as It Was Printed at the Hague 1676." This is the Battle of Stromboli Jan 8, 1676: Ruiter was killed in the action near here usually called the Battle of Agosta April 29, 1676.

[7] P 388 his work. See opp p 527 below for picture from Brandt's Life of Ruiter of a battle in 1673.

[8] Above p 314, "Sails at the yard arms;" see also the sketches ascribed to Columbus above p 311.

in the best season and best way possible must have been attended to.[9] Charts were employed from early date and the oldest preserved which can be called by the name are the portolans [1] which we have of date beginning 1300. There are as already stated written directions for ships of earlier dates; but no drawn map seeming even to purpose to show direction of date earlier than 1300 has been preserved unless indeed those accompanying Ptolemy's geography were made by him.[2] It is usually said the portolans were made with the aid of compasses because direction is correct, while in maps of earlier day almost no attention to this has been paid; and while no doubt the compass was used in making portolans the absence of attention to direction in earlier maps does not prove the case for direction could be determined in pre-historic days.[3] Portolans are sometimes called the earliest charts but charts used by seamen must always have shown direction, for they would be useless not charts at-all without this; but if maps such as the portolans were used in ships they had 2 characteristics the preserved portolans have not; (1) they were of inexpensive character and (2) on scales larger than that of many of those which have been preserved.[4]

The author lately referred to, Anthiaume, believes the maps of Ptolemy which Macoudi saw about 925 [5] were made by Marinus of Tyre whose date is just prior to Ptolemy, adding, " These charts which still existed in the 10th century may be considered with much confidence as the first source of the portolanos of the Middle Ages." [6] Nordenskiold says in his Periplus,[7] " There are no true sea-charts extant from the first thousand years of our era nor are sea-charts or maps intended for navigators mentioned in the literature of that period excepting those ascribed by

[9] Clarke's Clipper Ship Era shows that about 1850 voyages a few years before deemed impossible were made: see also account in Reed's Naval Science p 265 v 2 1872 of the race from China to London 15000 miles of 5 tea-ships: no ship saw any other and the 2 in the lead found themselves abreast in the English Channel on the rising of mist running under a press of sails in a south-west gale: p 669 below.

[1] Above pp 296 and foll'g.

[2] Above p 46.

[3] Breasted Hist Anc Egyptians p 94 says the oldest buildings are oriented with accuracy rivaling that with modern instruments.

[4] There are exceptions: the chart in Fabri's ship 1480 was 30 miles to one inch, see note 5 p 293 above; the scale of the Carte Pisane is 60 miles to an inch, see p 297. See pp 321 below and foll'g as to cost of early charts.

[5] Above p 46.

[6] Anthiaume cited n 6 p 306 above p 363: this author wrote also Cartes Mar, Constr Nav, 2 vs illus 1916.

[7] P 16.

Ptolemy to Marinus of Tyre." It is a temerity to amend anything coming from the distinguished Swedish geographer whose Periplus and Facsimile Atlas are so important in the history of maps, but will be admitted that not only are there no sea-charts of the first thousand years of our era but no maps or charts whatever except those he mentions of that period; and the important thing is that these were made by Marinus of Tyre from logs of ships, for until one and three-quarter thousand years of the Christian Era had gone by maps could be made in this way only. Were not the records of skippers, carried only by memory sometimes, maps? They required only to be systematized and results plotted, which was done by Marinus and Ptolemy, to make maps as well as the written sailing directions of earlier date which have survived. To these we come presently noting here that they were formed from ships' logs. From them to a drawn map *painted* it was called is but a step. Charts are more perishable than written documents; they were made by pilots as needed and exhibiting only coast-lines and harbors were not cared for after use.

The old maps preserved are superbly made [8] and often on small scale to be used in ships. Yet those who made maps from the records of ships must have drawn them large. Let us try to see Marinus of Tyre at work: he had an office little like modern offices 19 centuries ago in Tyre where seafaring was already in his day 1000 years old and when a skipper returned and told his story Marinus drew the ship's track out, adding here and there a picture and written legend. No harm could come from drawing it large—complicated machinery is often drawn 4 or 5 times its size to avoid error. If Marinus drew it small and skippers who had made voyages to intermediate ports came to report there might be difficulty in working it all in on one sheet. So Marinus used probably a large sheet. The Catalan and La Cosa maps [9] of 1375 and 1500 respectively both show the world and the copies of them now extant are about 200 miles to an inch, too small for ship use. Further the coast-lines places shown and legends are so numerous it is hard to believe they were not made first on large scale.

[8] See Fiske Disc America v 2 p 13 note 1 regarding the beauty of the map made 1500 by the pilot La Cosa: the island Guadalupe is shown 2216 miles west of the Cape Verde Islands; correctly the distance is 2100. The map shows the world, is drawn on oxhide, and is now in Madrid. Its scale is 200 miles to one inch; the day's-run of a ship would be about ½ inch long. The scale of the Carte Pisane made 200 years earlier is 60 miles to an inch. Reproductions of Cosa's map and Carte Pisane in size of the originals are in Jomard's Mon de Geog.

[9] Above p 302 and note immediately above.

WRITTEN GUIDES NOW CALLED COAST-PILOTS.

There are extant ancient *written* itineraries whose data came from ships, being probably drawn up by seamen as charts were drawn and painted by them.[1] Of written itineraries there are several the oldest being the Periplus of Scylax.[2] It is believed the rules of Scylax grew to present form in a long period; from as early as 600 to 300 B C probably. In regard to the west of Europe this reads, " The Pillars of Hercules are opposite each other and are distant from each other by one day's sail. And thereby lie 2 islands by name Gadeira.[3] Of these the one has a city which is one day's sail from the Pillars of Hercules.[4] Beyond the Pillars of Hercules that are in Europe are many trading places of the Carthaginians and mud and tides and open seas."

We pass next to the *Stadiasmos of the Great Sea* of about 250 A D, a coast-pilot of the Mediterranean: in it is written, " From the Hermæan promontory to Leuce Acte 20 stadia. A low and small island lies there distant from the land 2 stadia. There is a sheltered roadstead for merchant vessels against the west wind. But on the land under the promontory is a spacious roadstead for all kinds of vessels. A temple of Apollo with a celebrated oracle; it has water by the side of the temple." [5]

We go forward now more than a thousand years to this writing on a portolan of 1450, " Cartagena is a good port at all seasons xx. Sail close to the middle of the channel but afterwards to the N E shore where you may anchor xx. Enter the port keeping the mainland about 2 prow's-lengths distant where you find 6 and 6½ fathoms of water. About the year 1445 xx a ship was wrecked here during a calm." [6] This will be regarded

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[1] Above n 6 p 306 for Anthiaume: see also Tozer Hist Anc Geog pp 236, 308, the Roman *itineraria picta, itineraria adnotata, itineraria maritima;* painted, written, maritime itineraries.

[2] Periplus Nordenskiold pp 5–9. The author has supplied a map (N. T. I) showing tracks corresponding with the *written* itinerary of which he gives copy and such a map must have accompanied written itineraries. From Scylax' Periplus Nordenskiold concludes (p 9) average runs in its time were 40 geog miles per 24 hours. This is distance made good; not the ship's speed which would be more.

[3] Cadiz: all land discovered was called island until the contrary was proved.

[4] The narrowest part of the Strait is 10 miles wide; from Gibraltar Bay to Ceuta is 25 miles; from Tarifa in the Strait to Cadiz 50 miles.

[5] Bunbury Hist Anc Geog v 2 pp 673, 667. There is no compass-bearing or wind-direction here or in the Periplus of Scylax. In a note p 667 same v Bunbury is a sailing directions among islands of the Ægean in which there is one bearing; named as usual in early days by the name of the wind: an east wind is still called a levanter in the Mediterranean.

[6] Stevenson Portolan Charts p 13.

as the best sailing directions of the three given as it states a sounding. Soundings however were made in pre-historic days; Herodotus gives one, stating the character of bottom brought up[7] and they are not infrequently mentioned in old books. The Sailing Directions of Timosthenes in 10 Books of date about 250 B C described p 327 below also show how early ships kept systematic reckoning.

COST OF MAPS.

Portolanos may be seen in many places,[8] but not the kind seamen used being far too costly. Vespuccius once bought a map and wrote on it, "For this large geographical chart Amerigo Vespucci has paid 130 gold ducats." [9] In an inventory of prices of articles in a ship captured in 1294 we find another sort of chart. There were 3 charts in the ship valued in the inventory at 7 *tarins*. This word is not found as a coin in French dictionaries but Spanish ones give a tarin as worth a real and these are several reals. The article from which this is taken says 7 tarins are equivalent to about 20 cents of our money. The captain and 2d captain of the ship had sets of writing utensils, which is interesting as it is often asserted mariners of these days could not write nor figure.[1] In these days there was no printing and materials necessary to make maps were costly: Hallam writes,[2] "From the conquest of Alexandria by the Saracens at the beginning of the 7th century when Egyptian papyrus almost ceased to be imported into Europe to the close of the 11th about which time the art of making paper from rags seems to have been introduced, there were no materials for writing except the expensive parchment." It may be added that for long after the date at which we are arrived charts were produced by private persons: a recent English author writes in editing the Life of Capt Martin, whose date was 1666–1740, "The provision of charts was in those days a private speculation for there was no admiralty hydrographer until 1795." [3]

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[7] Above p 47.

[8] Facsimiles are in larger libraries.

[9] It was made by Gabriel de Vallsecha in 1439 and is now in Palma, Majorca; see Thompson, Rose of the Winds, p 5, noted above p 270 n 4. There have been ducats of different value; this sum probably means about $300. See below pp 348 and foll'g for costs of navigational articles in Magellan's fleet.

[1] Inventaire de Bord en 1294 Ronciere; in Bib Ecole des Chartes 58 1897.

[2] Hist Europe during M Ages Colonial Press v 3 p 22: above, n 8 p 319 as to material Cosa used to make his chart.

[3] P xxvii Eng Navy Rec Soc Pub Life Martin.

WAYS IN SHIPS ABOUT 1400.

We have the history of Don Pedro Nino Conde de Buelna a noble Spaniard born about 1380, where we read,[4] " The galleys left Alhavina there being almost a storm on the sea the wind strong from the west. The hardy sailors put things to rights. They adjusted the compasses primed with the magnet-stone opened the navigating charts and commenced to *prick the chart and measure with rule and compass* x x. They *watched the sand-glass;* they give to the master close attention. x x x They commenced to navigate in the name of God, the wind was fair all day." A little further on,[5] " We sounded and found bottom at 70 fathoms. We knew that the bottom was stones and pebbles but the lead brought up sand." It is by this indicated soundings and the character of the bottom were written on the chart in the places they belonged, which could not have been done unless the scale of the chart was large: it proves more than this, even if written on a separate sheet with indication of the spot in which each determination fell on the chart it shows soundings and samples of bottom had previously been taken in positions fixed by bearings from shore. If the shore was too distant to see soundings were taken as the ship ran a course steadily measuring speed with care, so that depth and character of bottom might be put down in the right places. That they, " Opened the navigating charts and commenced to prick (that is to mark, the word prick is still used in the signification) the chart and measure with rule and compass " also shows the chart was on large scale and correct of course. They wished to learn how far they were from some port and used dividers to measure as would now be done, and unless the run of the ship in some hours would measure on the chart about a half-inch it would be impossible to measure. There is no mention in Nino's Chronicle of an astrolabe or instrument for measuring angles.

RAYMOND LULL.

There are several ways of spelling Lull's name but the above seems to be the English way. He was born in Majorca one of the Balearics in 1235; these islands became part of Catalonia, wherein is the maritime city

[4] Chronica Pedro Nino por Games Madrid 1783; the part quoted is p 83. The ed is in old Spanish; *sand-glass* is *relox de arena,* clock of sand. The Chronica is also in Mem Hist sobre Marina Comercio etc Barcelona Capmany y Montpalu 4 vs in 3; v 3 and 4, p 74. See above p 287 for nearly co-temporary account of how ships voyaged.

[5] P 87. As to sounding see just above. Why was the sand-glass watched? to ascertain speed?

of Barcelona, and Lull who wrote in Catalan as well as Latin is called a Catalonian. An important passage in his writings is this, "In what way do mariners measure a mile at sea x x. For this purpose they have as instruments charts compasses needles and sea-stars."[6] Lull wrote a treatise on navigation it is said, an *Arte de Navegar*, of which an authority says,[7] "Lulio reduced to a system of nautical doctrine the practices used and observations made by the seamen of the levant and of the ocean, and combining them with the principles of the exact sciences especially of astronomy which had been so much cultivated by the Arabs and Spanish rabbis wrote various scientific works, among them the *Arte de Navegar* x x. In one work written in 1295 he gives excellent rules for mariners as to x x the stars and the compass the rhumbs and distances he goes[8] x x. He says in his *Geometria* that upon it depends nautical science and among his drawings he notes an *estrolabio* to know the hours of the night. In his *Arte General Ultima* x x he traces a figure divided into 4 triangles, formed of right acute and obtuse angles like the *quartieres* which serve today so much in the practice of navigation[9] and he shows how by means of this the distance a vessel has gone and the course she has followed with respect to the cardinal points is known and the place where she is at any moment x x." In one place Lull mentions an astrolabe; *estrolabie* it is spelled.[1]

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[6] D'Avezac Coup d'Ocil Hist sur la Proj des Cartes de Geog 1863 p 88; Periplus Nordenskiold p 16. The original passage is said to be in Lull's *Arbor Scientia* but the copies of this I have seen do not contain it. See above p 300.

[7] P 114 Obras de Lull etc Rossello Palma 1859: the Descubrimiento de la Aguja Pascual Madrid 1789 p 65 says Lull wrote an Arte de Navegar and that it was the first written.

[8] *Los Rumbos y distancias que andaba* in Pascual: in modern sea-phrase the meaning is the courses and distances run.

[9] Navarrete and Rossello wrote in Spanish and both use the word *quartieres* not found in Spanish dictionaries; in Littre's French dictionary it is defined, "Marine term, *quartiere de reduction,* graduated card serving to reduce oblique courses; that is to say those whose direction is on neither a meridian nor a parallel to the equator; the quartiere of reduction is no longer used except onboard small merchant vessels being replaced everywhere else by tables calculated in advance." Navarrete wrote about 1820 and the edition of Littre quoted was printed 1885. The *quartieres* were for the same purpose as our traverse-tables; the same as the lines at right angles on the Carte Pisane, see above, p 297; the same as the martolojo, see below pp 330 and foll'g.

[1] Obras de Ramon Lull Obrado y Bennassa Palma de Mallorca, 1906–14 8 vs v 1 p 132; in Catalan and in the Boston P Library and may-be elsewhere. I have been unable to procure satisfactory trans of the passage entire.

RAMON MUNTANER.

As regards methods of navigating in the Mediterranean in the day of Lull there is another authority. In 1283 the Queen of Catalonia went in the greatest ship of Barcelona from that port to Sicily going without touching and taking her two sons. Much is recorded of this and of the preparations and ceremonies accompanying the leave-taking written in the Catalan dialect by Muntaner, and in an English translation we are told the ship was provided with *bucons* and *arganels*, which words the translator explains mean compasses and astrolabes.[2] This is the earliest mention of an astrolabe in use in a ship, 1283; in 1242 we have mention of a compass in use in a ship on the coast of Syria; and in 1270 of a chart thus used near the coast of Sardinia;[3] 3 circumstances of interest but not importance as respects the original use of these appliances by ships, for this was much earlier.

Another interesting thing in Muntaner is this: a boy who lived with his mother at Brindisi and was son of Roger di Flor who organized the Catalan Grand Company in Constantinople about 1302 was always climbing about ships in the port and Muntaner says of him, "When he was 15 he was considered one of the best seamen in the world in practical things and when he was 20 he had all the theory of a seaman and of navigation."[4] We read no more but the words imply there was a theory of navigation; *marineria* it would be in Spanish and the same in the Catalan, or perhaps *marinatge* the old form of the word.

SIR JOHN MAUNDEVILE.

Sir John Maundevile travelled in years 1322 to 1356 and though his reputation for truthfulness is not good his writings reveal customs and ways of the day.[5] He writes for example, "In that land no man may see the star transmontane that is unmovable x x that we call the Lode Sterre. But men see another sterre the contrairie to him that is towards the south that is clept Antartyk. x x If a man found passages by ships man might

[2] Chronicle Muntaner trans Goodenough Hakl p 229. There is a French trans by Buchon 1827 and the Lib Congress has the chronicle in Catalan. Muntaner wrote in 1325: see p 485 below for him again.

[3] See pp 265 above as to compass and 428–29 below as to chart.

[4] Buchon's trans Muntaner v 2 pp 111–135: see below p 495.

[5] Voige and Travaile Sir John Maundevile Halliwell; Early Travels Palestine Comprising Narratives x x Sir John Maundevile ed Wright 1848. The quotation is pp 178–83 of last.

go by ship all about the world and above and beneath. I have seen the star that is clept transmontane 53 degrees high; x x and more forth toward the parties septentrionales it is 63 degrees of height and certain mynutes. For I myself have measured it by the astrolabe x x. I have been under the antartyk 33 degrees and 10 mynutes x x. They that be towards the antartyk they be straight feet against them that dwell under the transmontane x x. And when a man go beyond these journeys towards India and to foreign isles x x the roundness of the earth and of the sea is under our country on this half. And therefore hath it befallen many times of a thing that I have heard counted when I was young, how a worthy man departed some time from our countries for to go to search the world and so he passed Ynde and the isles beyond Ynde where been more than 5000 isles, and so long he went by sea and land and so environed the world by many seasons that he found an isle where he heard speak his own language calling on oxen in the plough such words as men speak to beasts in his own country, whereof he had great marvaile, for he knew not how it might be. But I see that he had gone so long by sea and land that he had environed all the earth x x."

Maundevile must have died by 1360 full 100 years before the great long-distance voyages yet his words show he understood that stars near the poles appear or disappear as one goes north or south, that this phenomenon could not have been unanticipated by seamen: as he picturesquely says the feet of men at one pole are straight against feet of those at the other. His words show that in his day a measurement of the altitude of a celestial body by an astrolabe was a familiar thing to those whose pleasure or business led them to enquire. Whether Maundevile was where the altitude of the north pole-star is 63° and stars at the south pole 33° 10′ is immaterial; it is enough that he imagined it. This is almost certainly what he did do and yet if he or someone had been in latitude 33° S things in early writings and maps now unexplained would be made clear. Since these extraordinary remarks of Sir John have been quoted it is only just to quote another, sober and accurate; "From Cyprus," he says,[6] "They go to the land of Jerusalem by sea and in a day and a night he that hath a good wind may come to the haven of Tyre;" the distance is 120 miles. This is 5 knots per hour the speed ships have made with pleasant fair winds and sea ever since there were ships.

[6] P 141 Early Travels cited.

RECKONING ON THE HIGH SEAS.

Ships could determine latitude by observation centuries before the Christian Era; longitude only about 150 years ago. Pilots and skippers could estimate change of position from one day to another when their mental powers exceeded those of dumb animals; when they could do this ships kept at first by memory dead-reckoning and maps were made and geography began. When they could write and calculate dead-reckonings accumulated; Herodotus almost our oldest writer had seen many maps though probably not the logs from which they were made. If it is asked could pilots keep written logs in Herodotus' day the answer must be, long before; Herodotus could calculate, as one may be convinced by reading what he says of the numbers of the host Xerxes brought to subjugate Greece; if he could do this others could also.

Herodotus measures the Black Caspian and Red Seas by runs of ships; in years following Eratosthenes Hipparchus one of the most remarkable astronomers of all time, Posidonius and others use these, and with them as the yard-stick reach correct conclusions. The records from ships stated only how far they had gone in this or this direction; to make more definite statement, how many days they had sailed in one of the directions they recognized, for the number of parts into which the horizon has been divided has differed in different lands and dates. In other words ships kept reckoning in what we call polar co-ordinates which give position by bearing and distance. So a captain would tell a friend regarding some port he had been to it is so far in such direction, and thus reckoning was kept for a long period. When intermediate coasts or islands could be followed as was frequently the case direction was stated with respect to these as in the Coast Pilots already described; only occasionally was it stated by an angle measured on the horizon. Ancient and mediæval seamen not having the compass called this angle by the name of the wind blowing from or towards some port they were familiar with and named points of the horizon also by the rising and setting of the sun and sometimes stars in different seasons: the points of summer equinoctial and winter rising of the sun were called by these names instead of north-east east and south-east; and so also for his setting. This was nearly accurate for bearings change little where change of latitude is little as in the Mediterranean.

Direction is defined by primitive peoples by position of celestial

bodies and direction of winds. One Timosthenes wrote a Sailing-Directions about 250 B C in which he defined it in this way [7] and of him Strabo says,[8] "Timosthenes the admiral of the fleet of the second Ptolemy who was the author of a work in 10 books on Harbors x x." Direction and situation in his work was no doubt of the character of the peripli examined above; the method was followed until a compass card showing direction was at hand; it is used with clearness by Polybius who wrote 150 years later than Timosthenes.[9] When however maps showing many places and long coast-lines are to be made the use of rectangular co-ordinates, latitude and longitude, is more convenient; for if numerous positions are set down by bearing and distance from one another as they come in from ships, not all from one center, confusion must result. If runs are reduced to latitude and longitude to lengths parallel to fixed lines so great confusion will not occur; but after all the map-maker has only shifted his difficulty and hidden it for however he works he cannot rise in accuracy above that of the records of the ships. Latitude and longitude, rectangular co-ordinates, are said to have been used by Ptolemy in making his maps and his Geography contains tables giving these for many places.[1]

HOW DID PTOLEMY PLOT POSITIONS?

I venture to break a very broken story: if as students of geography have concluded Ptolemy plotted position by the latitudes and longitudes in his tables how came it that portolan-maps the accurate maps made in years 1300 to 1500 were plotted by ship's-runs and courses, by polar co-ordinates? The maps we have of years 1300 to 1700, why are those radiating lines drawn all over them? The Carte Pisane and Catalan Map, the last covering the world with thousands of positions plotted all things considered with wonderful precision; why are they confused by lines radiating from several points? It was not done in wantonness. There was a purpose that led cosmographers and pilots to draw on charts not the lines at right angles we use but radiating lines, and the

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7 Bunbury Anc Geog v 1 pp 587–9, 610–11. See above pp 320 and foll'g for other early Sailing-Directions.

8 V 2 p 120 Bohn in 3 vs (bk 9, 3, 10): Tardieu another translator renders the passage, "Who was author of a famous Portulan in 10 books." The Ptolemy referred to reigned 283–247 B C; during his reign the great light-house at Alexandria was finished and lighted. Strabo's date is 25 B C.

9 Shuckburgh trans bk 3, 36, 37.

1 Bunbury Anc Geog v 2 p 550: also note on that p as to Greek words *mykos* and *platos,* length and breadth, which have come to be *longitude* and *latitude.*

purpose was to enable them to use runs and courses without change. With these lines and the scale of length on portolans they are complete. The device on the Carte Pisane for converting runs and courses to latitude and longitude and the martolojo shown 150 years later on the map of Bianco are signs of a coming change, some seamen used these and some the old way—the radiating lines. In the only sample we have of Ptolemy's use of ship's-runs and courses, the description just below of the voyage between Palura and Curura, only courses and distances are mentioned; the changes of latitude and longitude corresponding are not alluded to. The question is dwelt on because important in discovering what seamen did with reckonings.[a]

THE COMMERCE OF ALEXANDRIA IN THE DAY OF TIMOSTHENES, 250 B C AND LATER.

Beside what is just quoted from Strabo about Timosthenes' Book of Sailing-Directions this author tells of the Nile-Red Sea canal and trade to the Far East.[2] As to the last he writes, "The greatest advantage which Alexandria possesses arises from its being the only place in all Egypt well situated by nature for commerce with the sea by its excellent harbor and with the land by a river by means of which everything is easily transported and collected together into the city which is the greatest mart in the world. x x Cicero states an annual tribute of 12000 talents was paid to Ptolemy Auletes (reigned in the time of Timosthenes); x x what must it be at present for then hardly 20 ships ventured to navigate the Arabian Gulf or advance the smallest distance beyond the Strait at its mouth but now large fleets are despatched to India and the extremities of Ethiopia (that is far south on the east coast of Africa) from which places the most valuable freights are brought to Egypt and thence exported to other parts so that a double amount of customs is collected x x." Here is information from a reliable historian as to Greek or Latin shipping east from the head of the Red Sea from 300 B C to 100 A D say.

PTOLEMY AND MAPS AGAIN.

Marinus of Tyre and Ptolemy both of about 100 A D are usually said to have plotted by latitude and longitude. They do not say anything as to the form in which the data they used came to them; whether as now

a See pp 352 and foll'g below as to charts drawn with radiating lines.

2 P 244 v 3 (bk 17, 1, 25) for first; pp 234–5 v 3 (bk 17, 1, 13) for second; Bohn ed in 3 vs.

ships immediately changed courses and distances to differences of latitude and longitude or brought in courses and distances unchanged, but Ptolemy's maps and tables were in latitude and longitude and seamen must have understood how to employ these.[3] The only statement indicating how early seamen handled reckoning is dealt with above; [4] it is taken from Ptolemy by the French geographer Gosselin and is as follows, " Here is an example taken from the Prolegomenes cap 13. The seamen and Marinus following them had said that the navigation between Curura and Palura took the direction of the winter-rising and that it was of 9450 stadia x x." [5] From the analysis of Ptolemy's words given above it results that seamen wrote down courses and distances run; but understood, originated indeed, the process used by Ptolemy in making calculations regarding Palura and its locality. The seamen who furnished the information were probably Arabs though Greeks and Latins were in the East before the day. A map in Gosselin's work just cited [6] shows written off the coast of India near Palura, " *Locus unde solvunt in Chrysem navigantes;* " that is The place where ships for Malacca take the sea.

All early voyages state courses and distances which in effect constitute dead-reckoning, traverses we would say now; and peripli, sailing-directions written from the records of voyages in the same time and in mediæval days do this also. Not until the Middle Ages do we find mention of ships being supplied with aids for converting courses and distances into difference of latitude and longitude. The process was used earlier probably in ships onboard which the captain and pilot had a scientific turn but I am unaware of mention of these aids earlier than that of Raymond Lull in his Arte de Navegar written about 1290.[7] Some apparatus, a triangle with sides hinged *quartieres de reduction* or *martolojos* preceded the table now used; and the introduction of the earliest of these apparata marks a day considerably before which ships reduced their runs to latitude and longitude at once. The run in original form, so many days in such directions, was probably at first the only record kept.

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3 See Padouano Italian trans Ptolemy's Geog p 14.

4 Pp 41 and foll'g.

5 Gosselin Geog des Grecs Analysée p 116. The words after the period, *The seamen* and following, are Ptolemy's.

6 No 8: it shows what we call the Bay of Bengal and land near it, Chryse or the Peninsula of Malacca Sumatra Java India.

7 Above p 322.

THE MARTOLOJO.

The *martolojo* is shown on a chart on which is written, "Andreas Bianco of Venice made me 1436;" it is a device to convert courses and distances into changes of latitude and longitude. Bianco was a seaman as is shown by his signature on a portolano in 1448 when he commanded a Venetian galley at London.[8] The *marteloio* or traverse-table on Bianco's chart has been analysed by Formaleoni and while not as convenient to use as our traverse-table the quantities with which it is entered and those taken from it are the same.[9] Formaleoni states reasons for believing the word martolojo is Greek and believes it was used to steer by before the compass was available.[1] When Bianco's chart was making in 1436 ships were as far south on the west coast of Africa as 25° N; seamen's needs were extending and new treatises forthcoming, none introducing principles or methods but improving and simplifying. In the *Regimento do Estrolabio* Rules for Astrolabes a Portuguese work bearing date July 14, 1493 [2] is a *Regimento para saberes quantas leguas entram por grao por cada uma destas quartas abaixo escriptas e isto do norte e sul;* that is Rules serving to determine how many leagues must be counted by degree for each point described below and that from north to south. Then follows what we call a traverse-table for each point each *quarta:* Bensaude explains, "The word *quarta* corresponds to 1/8 of an angle of 90° on the compass;" that is to 11¼° the angle English-speaking seamen call a *point.* Following this came other books; Zacuto's Almanach Perpetuum containing tables of the sun's declination like those we use,[3] Tratado del Esphera y del Arte de Marear con el Regimento de las Alturas Faleiro [4] 1535; Tratado da Esphera Pedro Nunez 1537; Suma de Geographia Fernandez de Enciso 1519; and others.

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[8] Nordenskiold Periplus p 53. For Bianco's chart see picture here inserted.

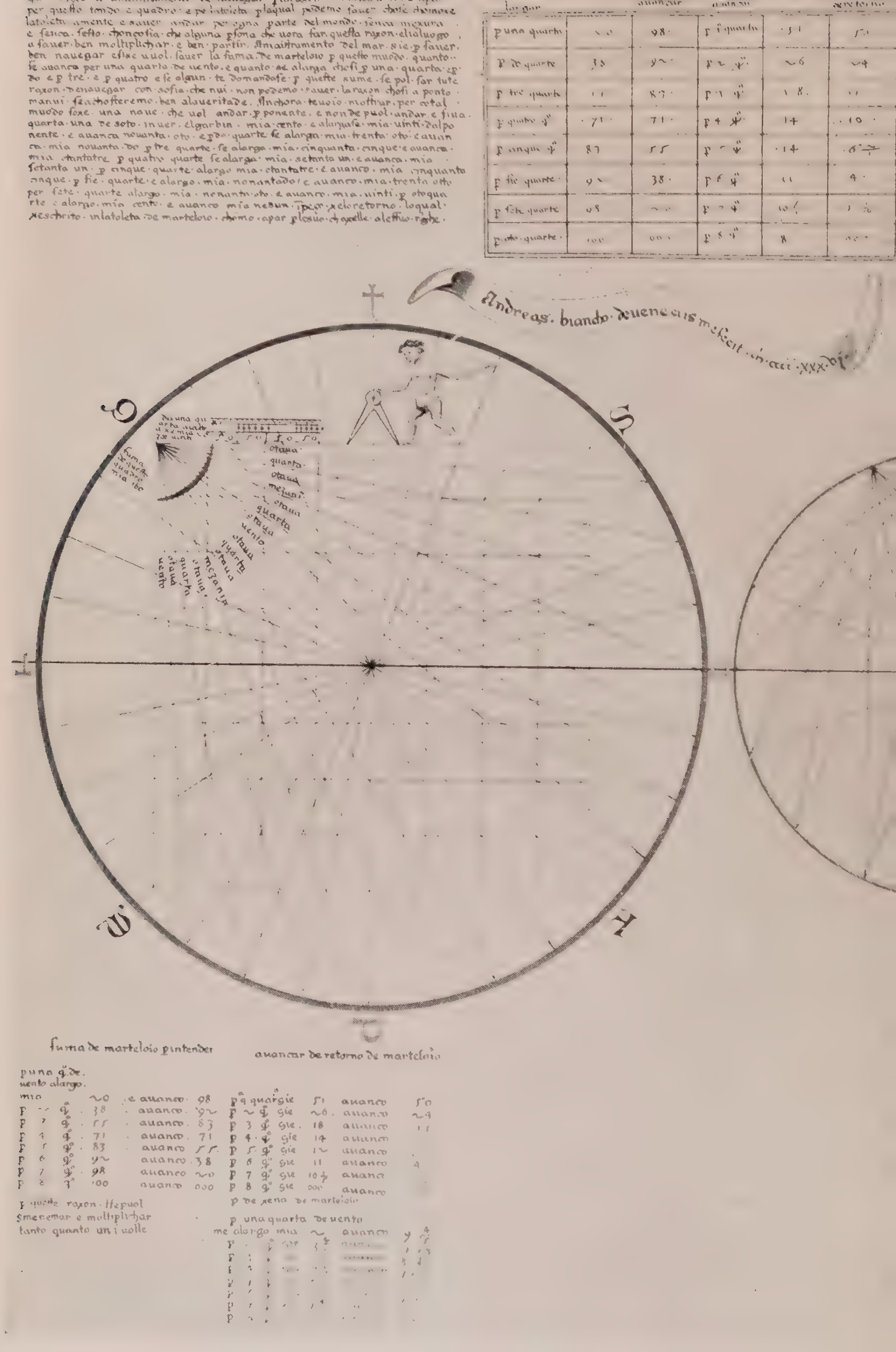
[9] Formaleoni Essai sur la Mar Anc des Ventiens trad D'Henin 1788 pp 50, 76; see p 56 as to the log called *barchetta ou loch.* See Nordenskiold Periplus p 53 where the martolojo is discussed and numerical examples of use given: the *quartiere de reduction* is in effect the same as the martolojo: see also p 152 Bensaude, Astron Naut au Portugal.

[1] Pp 44, 77.

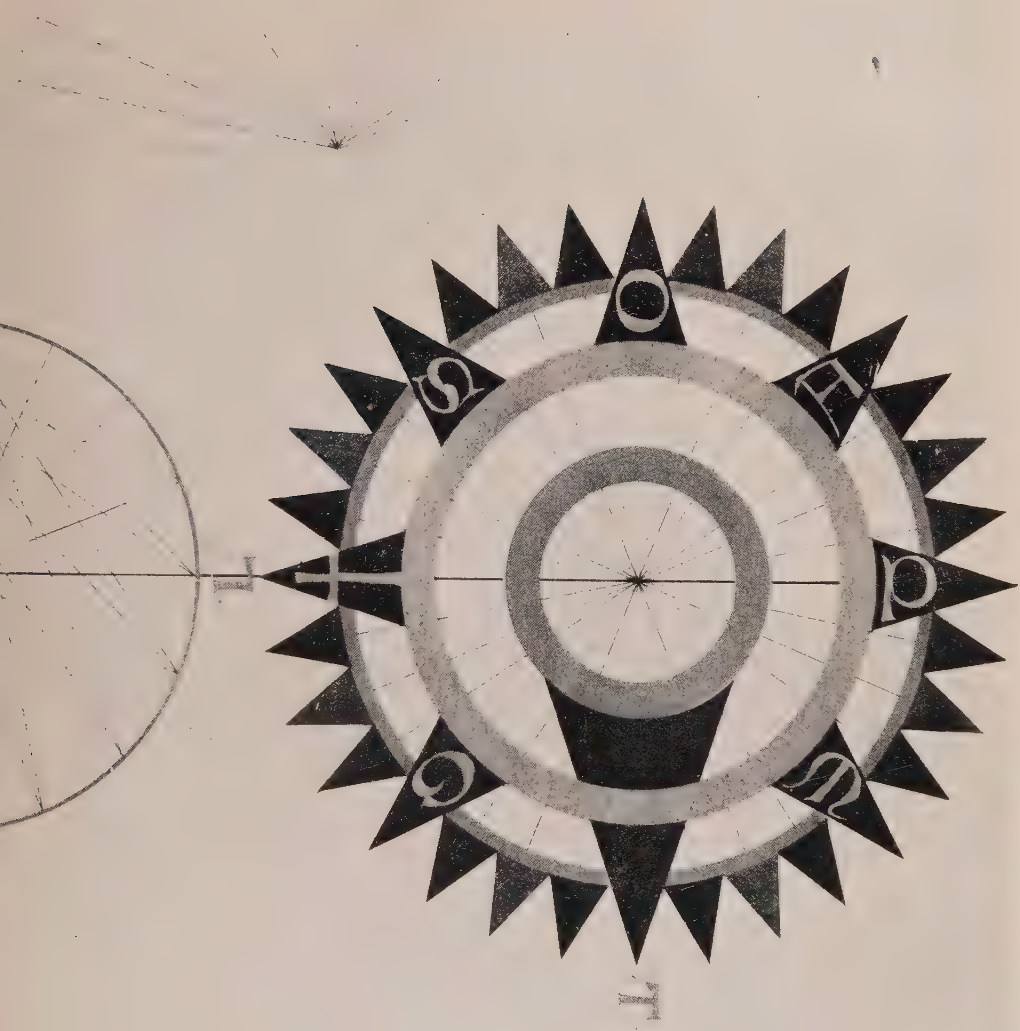
[2] Bensaude Hist de Science Naut p 147.

[3] Ravenstein Martin Behaim p 18: early astronomical tables are discussed parts being given.

[4] Faleiro was a friend of Magellan and was to have gone with him but did not; he wrote a treatise showing 3 ways of getting longitude at sea: Magellan's pilots probably had copies of this.



The marteloio of Andrea Bianco, 1436; from p 176 Raccolta Columbiana identified legend of picture p 7
the same may be done by measuring in the square to the left divided into small squares: the division of the
method was followed,—the little figure measuring with dividers shows the same. The use of the lines radia
why are the sides of the large square divided into 8 a



y the tables on the sheet differences of latitude and longitude may be arrived at from courses and distances:
t upper left hand corner of the large square into 16 angles, into angles of $5\frac{5}{8}°$, $\frac{1}{2}$–point, shows this graphic
center, which are $^{360°}/_{32}$, $11\frac{1}{4}°$, or 1 point, apart show the same. There is however mystery in this diagram;
corners not in the circumference of the large circle ?

THE MEASURE OF ACCURACY OF OBSERVATIONS FOR ALTITUDE AT SEA.

Pilots in early times wrote down how nearly they believed their ship's position could be relied on; we have such a statement from a pilot who was in the fleet of Cabral going to the East Indies in 1500: "Yet no-one can know," he says,[5] "Who is right before arriving at the Cape of Good Hope. There it will be known who navigates best, those with the chart alone or I with the chart and astrolabe. x x It seems to me almost impossible to take the height of the stars at sea, because however little the ship rolls one makes errors of 4° or 5° so that this can be done on land only. x x At sea it is better to find position by the sun than by the stars and is better to use the astrolabe than the quadrant or any other instrument." I cannot say why the astrolabe was better than the quadrant for they seem essentially the same, a graduated part-circumference carrying a turnable diameter on which sights were mounted, carried freely suspended on the observer's hand. Onshore where the point of suspension was fixed they gave good results, but in a ship where the point of suspension is in motion they swung at times in angles as great as 5°; when as they measured altitude from the vertical as a datum, their error was the angle they were out from the vertical. The pilot had discovered this though how we do not know. Pilots who navigated by the chart alone navigated by dead-reckoning alone pricking the position on the chart often;[6] our pilot found latitude by observation also using probably a meridian altitude of the sun. As however reaching the Cape was a matter of longitude this would not help much. There were pilots in these days who attempted to find longitude by observation but such attempts failed. One more remark must be made: the pilot's words show Cabral's ships carried charts; yet no ships of Europe crossed from Brazil to the Cape before those of Da Gama 3 years earlier.

PEDRO NUNEZ COMMENDS DEAD-RECKONING AND NAVIGATION BY CHART.

Nunez was a great cosmographer and wrote his Tratado da Esphera in 1537 as stated above. A part of this is a Treatise in Defence of Navi-

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[5] Bensaude Astr Naut p 112: Cabral had discovered Brazil and was steering across the S Atlantic for the Cape of Good Hope. He discovered Brazil because he was going by the correct route in the Atlantic, perceived and made public by Dias; see below pp 535 and foll'g: Cabral had gone too far west and saw Brazil; Da Gama went out 3 years before by the correct route but did not go so far west as to see Brazil—probably the south-east trade-wind was well to the east; Dias described the correct way of making the voyage 10 years before Da Gama followed it.

[6] Below, pp 339, 342.

gating by Chart wherein is written,[7] " Ptolemy found x x Cape Guardafui called by him Aromata was 83° from the meridian of the Canaries. The Portuguese placed this Cape, not by eclipses as Ptolemy had done nor by land x x but by making the long detour to the Indies. Yet I find that they too have placed it 83° from the meridian of the Canaries x x. Thus the same result has been reached by very different means and it must be concluded that the navigation of the Portuguese is more exact and better founded than that of any others." Cape Guardafui is at the mouth of the Red Sea. There is no other record that Ptolemy had opportunity to determine difference of longitude between it and the Canaries by eclipse, and if he did not his determination was by dead-reckoning carried across at Suez and down the Red Sea. The arc of longitude between the Canaries and the Cape is 71°, 83° is too great by 1/6. If dead-reckoning was carried from the Canaries to Cape Guardafui across at Suez before Ptolemy's day when there were no compasses and later by the Portuguese out around the Cape of Good Hope and the results agreed it must be admitted the work was close and careful.

FERNANDEZ DE ENCISO.

Enciso wrote the Suma de Geographia in 1519. He was a cosmographer and seaman commanded ships and started in life as a lawyer. He gives directions for sailing to the East and West Indies and treats of dead-reckoning the use of instruments at sea and charts; his book ends thus, " Here finishes la suma de geographia the sphere in Romance and rules for the sun and the north,[8] by which sailors can regulate and govern themselves at sea. Also is set down cosmography by *derrotas* and *alturas* [9] by which pilots may go forward. x x It is drawn from many and authentic authors, x x the two Ptolemys Eratosthenes Pliny Strabo x x the Bible general history and many others, and the experience of our times which is the mother of all things. x x Printed at Seville x x in the year 1519." [1]

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7 Bensaude work cited note 2d above p 135.

8 By Romance is meant the Spanish tongue. Rules for the sun and the north mean for latitude by meridian altitude of the sun and pole-star. In the Geographia is a table of the sun's declination; reprinted in Ravenstein's Behaim; it is arranged like modern declination tables.

9 By dead-reckoning and observations; seamen until long after this when they say *altura* mean latitude by observation. Enciso like the pilot in Cabral's ship contrasts position-finding in the 2 ways; above, p 331.

1 The words will be found at the end of the Spanish copy of Enciso's Geographia; " 1st edition—large paper—Seville 1519." We should not wonder at citing ancient authorities; Nunez as was seen just above quotes Ptolemy as to longitude of Cape Guardafui by eclipse and Columbus in determining how far he had to go on his first voyage depended on authorities Enciso names; see below pp 540 and foll'g, especially his citation from Esdras p 544.

DUARTE PACHECO PEREIRA WRITES THE ESMERALDO DE SITU ORBIS.

Pereira wrote in 1505 directions for 21 different voyages. He was born in Lisbon about 1450 and died 1533 and almost the only thing known about him is that his calling was the sea for he went to the East Indies with Albuquerque in command of a ship in 1503. He called his book Esmeraldo de Situ Orbis and in it are many sailing-directions, tables of latitude in northern and southern hemispheres, a treatment of finding longitude, of meridian altitude of the sun, of reckoning high water.[2] Pacheco gives his chapter 4 this title, "The route and navigation that ships bound to India should follow." Chapter 5 has this for heading, "How the route may be steered from Cape Verde touching first in India:" in this the only land to be seen is the cape of Good Hope and Rio del Infante, many courses and distances are set down and it is not advised to touch.[3]

WHAT KIND OF LOG-BOOKS WERE KEPT.

The orders given at early date by the King of Spain to ensure reliable logs are noted and the efforts of John Davis and William Baffin in the same line.[4] Early logs are imperfect and not until kept on regular forms was there much change.[5] Columbus' Journal of his first voyage the only one we have from him is of loose discursive character giving sometimes a course and distance for the entire day sometimes only one or the other of these very rarely an observed latitude and no longitudes. The regular forms were an improvement but it may be doubted whether the journals of Columbus and Magellan would be as interesting and informing if they had been kept on modern printed forms.

COLUMBUS' ERRONEOUS LATITUDES IN CUBA.

Columbus gives the latitude of the north side of Cuba at 42° about double the correct figure.[6] It is difficult to explain these latitudes but

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2 See ed in Portuguese Lisbon 1892 pp 11, 15–19: there is another ed 1903; with comments. He gives lat Cape of Good Hope 34° 30′; it is correctly 34° 22′: those who determined this may have been onshore.

3 See Ravenstein First Voy Da Gama pp 186–93.

4 Above pp 295; below 343.

5 Below p 338.

6 Ravenstein First Voy Da Gama Hakl pp XVIII–XIX concludes the error is Columbus' own because repeated: Navarrete Colec v 1 pp 44, 62 notes says 42° was the reading of the instrument used and the latitude ½ this, 21°; also that there were instruments which doubled angles by reflecting the ray of light as do modern instruments: see Rev Maritime July 1921 for art called Evolution des Meth et Instr de Nav where, p 82 this is shown with diagrams. See below pp 550, 552 as to these latitudes and picture at p 345 of effect of reflecting a ray of light.

cannot be that Columbus made the mistake. There were instruments that doubled angles but this should have been taken care of when they were graduated as is now done and if this was not done Columbus must be supposed to have been aware of such a matter: Navarrete's explanation does not explain and as it seems impossible to ascribe the errors to Columbus we must suppose they were made by a copyist. Some who have followed Columbus' writings have denied he was a skilful navigator but it is impossible he should have made so great errors as this. He designedly made wrong entries in his log at times: Feb 18 when returning on his first voyage and in sight of the Azores he wrote, " The Admiral says that his navigation has been very certain and that he has laid down the discoveries on the chart x x. He pretended to have gone over more ground to mislead the pilots and mariners who pricked off the charts in order that he might remain master of that route to the Indies as in fact he did; for none of the others kept an accurate reckoning, so that no-one but himself could be sure of the route to the Indies."

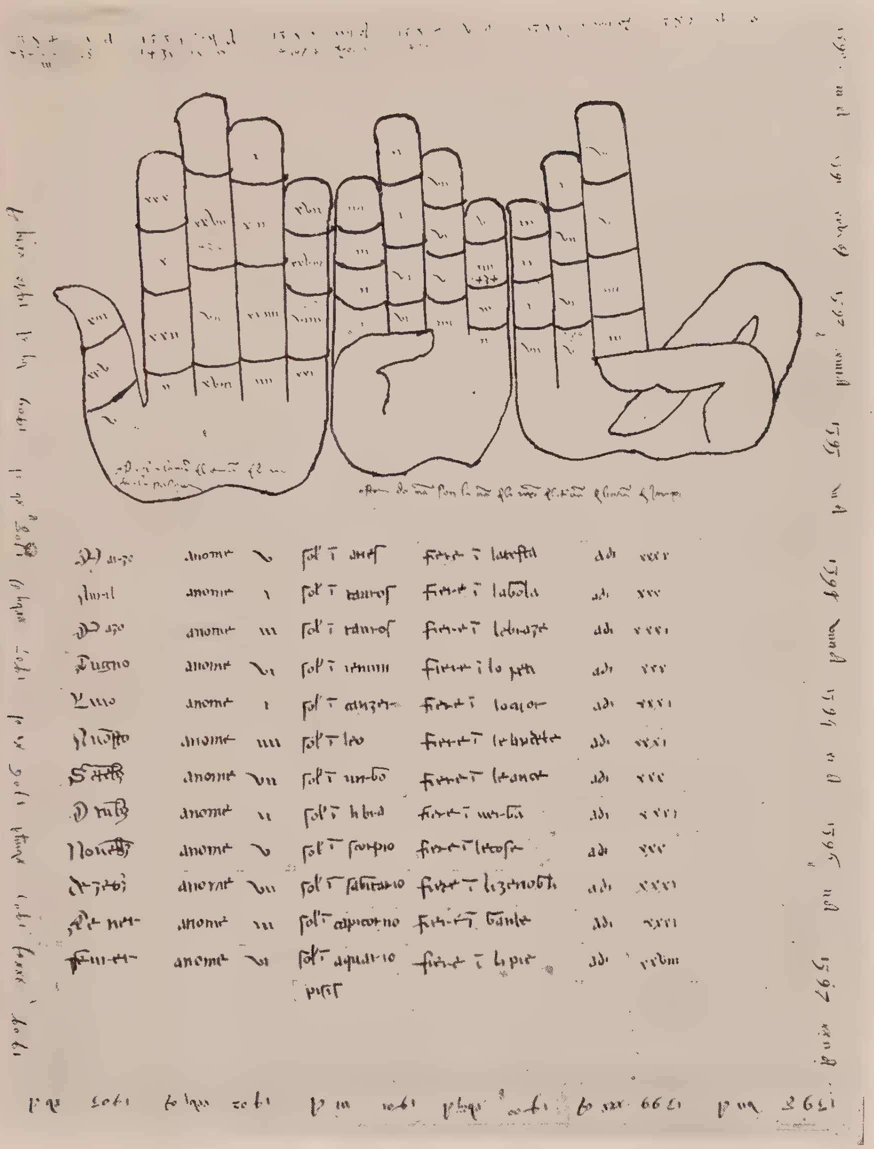
MAGELLAN'S LOG; KEPT BY FRANCISCO ALBO CHIEF PILOT.

Magellan sailed 1519 and Navarrete prints his Journal from Cape St Augustin in Brazil until the Return to Spain of the Ship Victoria Written by Francisco Albo.[7] It contains an entry for each day giving generally course and distance run and latitude by meridian altitude of the sun and is of few words; an official record. From it the track of the Victoria may be plotted. She followed the correct route across the Pacific but went too far south between Java and the Cape of Good Hope. This ship and the Trinidad the only ones left of the original 5, prepared to return home from the Spice Islands after Magellan was killed; the Trinidad being in bad condition steered for New Spain now Mexico, intending to go north to 40° where it was justly hoped to find west winds to carry her across the Pacific but constrained by the state of the ship and disease she returned reaching the Spice Islands 6 months after sailing.[8]

The Victoria sailed for home westward from the Spice Islands, though it is not clear why she did so for the purpose of the voyage was to reach

[7] Colec v 4 pp 209–47: here it is called *Diario o' derrotero del viage de Magallanes desde el cabo de San Augustin en el Brasil hasta el regreso à Espana de la nao Vitoria escrito por Francisco Albo.* In translating the word *derrotero* has been rendered *course* its present meaning; dictionaries give *derrota* as *ship's-course; derrota estimada* as dead-reckoning. As is obvious *diario* and *derrotero* mean also *log.*

[8] Below p 337.



This is a part of the 16th plate in Santarem's Atlas of early maps. This plate shows an accurate seaman's chart thus described by Santarem, "Portulan of the 14th and 15th centuries (1384–1434) given after the original, which belonged to the Pinelli Library; now in that of the Baron Walckenaer." I have been unable to discover how the hands held thus before the pilot's face aided in navigating, but there can hardly be a doubt that this is what the curious picture indicates. It will be noted its date is about 100 years earlier than that of Bianca's chart, on which the marteloio is drawn.

the East by the West avoiding as ships of Spain were bounden sailing in Portugal's seas. When she was in the Indian Ocean bound home around Good Hope Albo's Journal reads; [9] "On March 18, 1522 I took the sun in $40\frac{1}{2}°$, the declination was 2° 55′, the latitude was consequently 37° 35′. While taking the sun we saw a high island and steered for it to anchor but could not fetch. Took in sail and made repairs until next day. The wind was west. We took the board to the north under courses and were there until the 19th and could not get the sun. We were east-west with the island and it is 38° on the side of the south; it appears to be uninhabited without trees and its circuit is 6 leagues." It was Amsterdam Island latitude 37° 48′ S; the ship was 1000 miles too far south for the favoring S E trade and probably went there despite knowledge of foul wind to avoid Portuguese ships outward and homeward bound to India for she was in no condition to encounter enemies. Coming after terrible suffering crossing the Pacific more than $^1/_3$ the crew that left the Spice Islands were dead before she was off the Cape of Good Hope. Here she did not touch as she would have done had she dared.

ALBO'S RECKONING FROM THE STRAIT TO THE PHILIPPINE ISLANDS.

No keel had crossed the Pacific. As the crow flies the distance is full 10000 miles and as Magellan crossed about 12000, for he followed a correct course to find fair wind, deviating from the straight line. He left no record of his theories and plans but knew how far the Spice Islands are east from Portugal for he had made this voyage and knew the circumference of the earth and thus the distance to the Islands from the Strait. When he found the Strait the ships had been out from Spain a year his provisions were low and none properly put up could be procured in the wilderness; even filling with water, in wooden barrels perhaps shrunken from being left unfilled, was not a simple matter; and he could not have hoped to cross in less than 150 days; yet he had resolution to go on almost unencouraged by those with him and after suppressing or bearing with more than one mutiny. Some captains believed when at the east end of the Strait he would go east around the Cape of Good Hope where seas were known. It was an act of unparalleled courage.

The ships entered the Philippine Archipelago near the island of

[9] Navarrete v 4 p 230: the word latitude is *altura* in the Journal.

Suluan and of this Albo wrote,[1] "This island is at $9^2/_3°$ on the part of the north and in longitude from the *linea meridiana* 189° x x; a course W N W from E S E justly brings you to it." The latitude is correct as well as the course from the Strait to Suluan; of these the last is more worthy of note for many courses for differing distances had been steered. By linea meridiana Albo means its part in the Atlantic not that in the Pacific and he reckons east from that part; for if west 189° would carry over into Portugal's half of the earth and the Spice Islands so greatly desired would belong to her.

The longitude from the Line in the Atlantic to the Molucca Islands cannot be stated closely because the position of the Line cannot be fixed [2] but the longitude given by Albo is nearly correct, and considering it was by dead-reckoning carried out from Spain, for the longitude of no intermediate place was known, is as wonderful as the longitude of Cape Guardafui stated by Nunez.[3]

Albo states several latitudes in the Strait and some longitudes and is near enough correct to say that with the correct course across given and approximately correct longitude stated for the Philippines the form and principal dimensions of the Pacific were determined by him. The ships carried tables giving future positions of celestial bodies and these were tried in and near the Strait to determine longitude but without satisfactory result; latitude could be found by observation but the tables were clearly much in error: so little were longitudes determined by observation esteemed that those by dead-reckoning were preferred.

Almost in the same place in the Journal where Albo gives the longitude of Suluan nearly correctly and the correct course to it from the Strait we read, "From the Strait of All-Saints and Cape Fermoso to Suluan it is 106° 30′ of longitude." From Cape Pillar as the cape at the west end of the Strait is now called to Suluan the difference of longitude is 160°. The discrepancy is so great it must be ascribed to mistake in copying the manuscript and not to Albo.[4] Entirely satisfactory conclusions as to positions in these days cannot be reached for runs are in leagues and we do not know the length of a league. Markham in his Early

[1] Navar v 4 p 220: by *linea meridiana* Albo means the earth's circle north and south established by the Pope between possessions of Spain and Portugal; see below p 598.

[2] Below p 598.

[3] Above p 331.

[4] See below p 584 n 1 as to a blank longitude.

Voyages to Magellan's Strait puts the league at 3 miles [5] which may be used to show the Spice Islands are in the half of the earth belonging to Portugal; but if the league is taken at 4 miles for which there is also good warrant they are in Spain's half. A humorous writer of the day Peter Martyr d' Anghiera discusses distance-measures and adds,[6] "Let any-one who can understand this for myself I give it up." Martyr knew all the great seamen of the day. He says he had Vespucius Cabot and others at his table to hear them talk and may well have seen Albo and El Cano after their return to Spain for he lived until 1526.

AN ABSTRACT OF THE VICTORIA'S VOYAGE.

Here it may be well to place an abstract of the voyage of the Victoria. She arrived off San Lucar de Barrameda Sept 6, 1522 and anchored at Seville Sept 8, 3 years wanting 12 days after the original 5 ships sailed. Of about 275 men in all 5 only the 18 who returned in the Victoria accomplished the circum-navigation at this time: [7] the Victoria alone of the 5 ships returned to Spain. The sufferings were terrible, the crew of the Trinidad originally the admiral's ship suffering most perhaps. This ship accompanied the Victoria as far as the Spice Islands and attempted to return east to New Spain—Mexico. She sailed from the Spice Islands April 6, 1522 with 54 men; her captain Espinosa showing he knew the wind-currents by going to 43° N latitude. Crazy and water-logged, probably sunk till her deck was almost a-wash, she returned to the Spice Islands 6 months later with 19 men living but so stricken they could barely stand: she was seized by the Portuguese and the men imprisoned; of them 14 lived to complete circum-navigation going home by way of the Portuguese Indies.[8]

LONGITUDE.

In the Description des Indes Occid Herrera 1622 we come upon better longitude determinations. The author died 1625 having written another work about Spanish navigation published 1601. In the former work are 2 maps of the world on which all words are Spanish, and though the text is French and of the year 1622 it would appear these maps embody Spanish views regarding longitudes. The book has a number of longi-

[5] Hakl p 14 note.
[6] Orbe Nova Eng trans v 2 p 161.
[7] Magellan Guillemard pp 326, 336.
[8] Guillemard Magellan pp 302–309.

tudes in it and evidently progress was being made in mapping the earth. Bound with this is usually the Navigation of Le Maire 1615; a log-book but stating no longitudes. In this we have a notice of the discovery of Cape Horn though Drake is said to have seen it 25 years before. In Le Maire Jan 29, 1616 is written, "Two mountains to the west which was the end of the land which the President named for the honor of the City of Horne Cape Horne; it was in 57° 48′." This must have been measured onboard ship probably in a rough sea; Cape Horn is correctly 55° 59′. When the ship went north and crossed the Tropic of Capricorn it is entered,[9] "We had the *general wind* from E and E S E which here is usual; steering N W." It will be remembered that though Columbus does not allude to the trade-winds by name he was familiar with them and went north for westerly wind to return to Spain.[1]

REGULAR FORMS IN LOG-BOOKS.

The log of John Davis in the Desire in 1593 was probably kept on a regular form [2] for it shows for each day latitude course run wind and a column for remarks; the last being about variation of the compass. This is coming close to the logs kept now but it is not certain it was on a regular and printed form. The last came slowly but by about 1720 logs were kept much as at present.[3]

ANGLE-MEASURING INSTRUMENTS.

The first angle-measuring instruments were astrolabes; the first date in our history of them is 2500 years ago the day of Eudoxus or Apollonius and the details of their construction were laid down by Vitruvius about 25 B C.[4] They have retained from the first their essential form and character and Fournier wrote of them about 1650, "It is impossible to find a better instrument at sea." [5] That the instrument remained

[9] P 134.

[1] Above p 311.

[2] Voy John Davis Hakl p 282.

[3] Below pp 660–61 for origin of logs on regular forms. Fournier 1650 gives arrangement in tabular form, Hydrographie pp 557–8. Systematic logs were ordered at early date in Spain; "It was in the year 1527 that the Emperor ordered xx that great care should be taken by the captains and pilots (mæstros y pilotos) who came from Espanola and other parts of the Indies to write out the voyage they made in going and returning; and the same was ordered for all the vessels (*navios*) which might leave Seville so that at once should be fully understood the rules of this navigation" (*razon de esta navegacion*): Navarrete v 1 p CXXX, see above p 295.

[4] Above p 61.

[5] Hydrographie p 364; p 371 is illustration of one.

always the same is shown by astrolabes now in existence and by old pictures. The contrary has been asserted but though the lines and plates on them were changed according to problems to be solved the instrument has remained the same. Barros says when ships going south lost sight of the pole-star they, "Took the latitude by the sun; the use of the astrolabe for that mystery of navigation had for a short time only been acquired by the sailors of the Kingdom." [6] No change in astrolabes would be necessary to fit those measuring altitudes of the pole-star to measure altitude of the sun and Barros is in error. If this means anything it is that from that time on the plates of astrolabes or on a separate table was inscribed for each day the declination of the sun which had been unnecessary when latitude was found by pole-star.[7] In another respect Barros is wrong: he says navigators had in his day only recently been supplied with tables of the sun's declination, which is at variance with established fact; [8] he was not a seaman and misunderstood.

THE MEASURE OF ACCURACY OF ASTROLABES.

A pilot with Cabral said that when a ship rolls errors with astrolabes might reach 4° or 5°; [9] the error in latitude resulting if the observation were an altitude of pole-star or meridian altitude would be 4° or 5°, 250 to 300 miles. The pilot does not say what error he would expect in an observation of the sun, but it is unlikely he would put this below 1° or 2°, for though an observation by daylight is better because of good horizon yet the astrolabe's swinging would have the same effect. Even now star-altitudes are little esteemed unless the horizon is sharp and clear. Modern navigators believe they can measure altitude in favorable circumstances within a few minutes and determine latitude within a few miles. Observed latitude about 1500 was then dependable within 50 to 100 miles; the improvement made between then and now is due to better instruments.[1] We have however in these days remarkably close latitudes: 20 years after the

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[6] Asia dec 1, 4, 11. Maundevile said 150 years before he had measured the ht of the south pole at 33° 10′ elevation and that men at one pole were *straight feet against* those at the other: above p 324.

[7] Fiske Disc America v 1 pp 395, 492 says Behaim changed the astrolabe in these days probably following Barros: see Ravenstein Behaim and His Globe for the contrary view.

[8] Above p 236 for Astronomical Tables in 825 A D and n 2 that p for reference to others about 1250 A D.

[9] Above p 331; below p 342.

[1] Below pp 343–5, where is set forth the beginning of the use of instruments not hanging.

voyage of Cabral the Victoria discovered Amsterdam in the South Indian Ocean, probably never seen before by men of the race of her crew and Albo the pilot writes its latitude is, "38° on the side of the south;"[2] it is correctly 37° 48′. About 100 years later Le Maire determined the latitude of Cape Horn at 57° 48′,[3] it is correctly 55° 59′; the error is 109 miles. This observation may have been made onshore for there are islands near Cape Horn; but this is not likely as the sea is generally heavy in the region. Thus latitude by observation at sea in 1500 could be relied on within 50 to 100 miles; about the distance land of average height can be seen.

EARLY ATTEMPTS TO FIND LONGITUDE BY OBSERVATION.

Pigafetta a volunteer in the Victoria, an *idler* modern seamen would call him for he probably kept no watch, wrote, "At the present time the pilots content themselves with knowing the latitude and are so proud they will not hear speak of the longitude."[4] Robert Hues an Englishman born 1553 wrote, "Neither have we as yet any certain way of observing difference of longitude," as for, "Trifling impostors" who state the contrary he goes on, "And make public sale of their toys xx away with all such trifling cheating rascals."[5] But some observed for longitude. Vespucius may have done this in his first voyage in 1497: he writes after sailing from the Canaries, "At the end of 37 days we reached a land xx distant westwardly from the Isles of Canary about 1000 leagues xx. We found the north pole at an elevation of 16° above its horizon and it was according to the *showing of our instruments* 75° to the west of the Isles of Canary."[6] In another place in these Letters occurs this statement, "This land lies 18° south of the equinoctial line and 37° to the west of the longitude of Lisbon as is demonstrated *by our instruments*." Vespucius' 2 positions are not much in error for the S W corner of the Gulf of Honduras where his ship was when the first was made is 16° N and 72° W from the Canaries: his other determination must have been made while on the east coast of South America or near it. If on the coast 18° S falls at the town of Caraveles and this is 30° W from Lisbon; so the first determina-

[2] Above p 335.
[3] Above p 338.
[4] Voy Magellan Hakl p 167.
[5] Tractatus de Globis Hakl pp 137, 98.
[6] Letters Columbus Vespucius and Heriot; a letter to Soderini trans from Italian See also Amerigo Vespucci Varnhagen Lima Peru 1865: this last work does not refer to the longitudes cited.

tion is very close, the other not so close. It must be noted that both longitudes may have been by dead-reckoning though stated to be *by instruments*, for in regard to the first Vespucius says the ship ran west from the Canaries 1000 leagues, which if we take the league at 4 miles is 4000 miles: in the latitude in a degree of longitude is 53 miles and 4000 divided by 53 is 75½. Thus if Vespucius reckoned a league at 4 miles as he perhaps did do and reached both these longitudes by dead-reckoning the first is remarkably accurate and the second less so.

THE FIRST OBSERVATION RECORDED FOR LONGITUDE AT SEA.

Vespucius' longitudes the first in 1497 and second in 1501 may have been by dead-reckoning, though as Vespucius was of enterprising character it is not unlikely he used observations, checking the result by the ages'-old and familiar reckoning. He says of each it was by instruments and now-a-days this would mean by altitudes not by the log-chip. Next we have Pedro Sarmiento de Gamboa who took a ship in 1579 from Peru by the Strait to Spain and determined longitude by observation describing the instrument he used.[7] This is the first observation for longitude certainly made at sea.

In about 1600 William Baffin observed twice for longitude being for the first observation landed from his ship and onboard for the second; but perhaps she was fast in ice. Regarding the last Baffin wrote,[8] "The next morning being fair and clear and almost as steady as onshore xx having my quadrant ready xx it being indifferent large as of 4 foot diameter xx," and goes on to describe how he took a lunar observation. There is no way to tell how successful this was but plenty to show Baffin was an astronomer: he determined correctly the sun's refraction and alludes to great-circle sailing, sailing by the shortest way between places. Being in a fight in 1620 at Jashak near the entrance of the Gulf of Persia he was slain having, "Gone onshore with his mathematical instruments to take the height and distance of the castle wall so as to find the range for the better levelling of his pieces xx."[9]

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[7] Below p 625.

[8] Voyage Hakl pp 123, 20, xlix.

[9] Work cited pp XLVIII, 56, XLV for the 3 things mentioned: how were the guns to be laid at the angle he sought to measure; tables giving ranges for different angles of elevation were in the ships and a gunner's quadrant—a graduated part-circle supplied with spirit-level and plumb-bob.

FURTHER AIDS IN POSITION-FINDING.

The pilot with Cabral in 1500 was a certain Maitre Joao. If he was Joao de Castro he wrote 3 *roteiros* logs or journals which have been published. They are of 1530 and show Castro desired to determine variation of the compass at many places so that longitude might be found; yet he was far from believing this a sufficient method for he wrote, "The deviations of the needle do not correspond to the meridians." [1] Charts showing compass variations at many places were however made and something was hoped for from them the need being great, desperate we may say, for if a ship lost her reckoning there was no way to recover it. Such charts were made and ships determined variation; yet there was little hoped for. An English mathematician wrote a qualified approval of the method in about 1570 if,[2] "Proper instruments are in readiness by which the magnetic deviation can be ascertained with certainty." It was realized that as the variation is nowhere in excess of a few degrees it could not determine longitude all over the earth. This Gilbert proposes that ships determine latitude by the dip of the needle, which would fail from the same cause as longitude by compass variation; "Sailors when tossed about on the waves with continuous cloudy weather," he wrote,[3] "With a very slight effort and small instrument are comforted and learn the latitude of the place;" and goes on to tell how a dipping needle may be made and used. There is reason for the unwelcome often accorded innovators.

THE INHERENT ERROR OF ASTROLABES AND QUADRANTS AT SEA.

Angles by astrolabes at sea were always wrong for the instrument hung on the observer's thumb and swung with the ship. If the ship jumped smartly they must have gone 10° or 15° out of vertical. On land large heavy instruments carried by frame-work were employed and these were accurate; also the observer took his time, he was not obliged to catch the altitude on the fly so to say. The astrolabes and quadrants used by Columbus Da Gama Magellan and others were 6 or 8 inches in diameter and made of metal. On his first voyage Da Gama entered the Bay of St Helena north of the Cape of Good Hope and landed to determine the

1 Nordenskiold Periplus p 148 as to Castro, and Bensaude Astr Naut p 181.
2 Wm Gilbert On the Magnet p 166.
3 P 200.

latitude with,[4] " An astrolabe of wood *tres palmos* in diameter mounted on 3 poles in the manner of shears the better to make sure of and ascertain the solar line and they were able to know distinctly the latitude of that spot. They carried with them other small astrolabes of brass." St. Helena Bay is 150 miles north of the Cape on modern maps: Barros does not say what latitude Da Gama's pilots found.

ANGLE-MEASURING INSTRUMENTS HOLDING ON THE HORIZON, THE ONLY FIXED POINT AT SEA; NOT DEPENDING ON GRAVITY.

So far as the records show instruments for measuring angles onboard ships in the day of the Great Voyages depended on gravity; astrolabes quadrants and astronomical rings: they were hung on the observer's hand. The cross- or fore-staff though we have mention of it at least 100 years before these days [5] is not alluded to in any book of the time. The last held on the horizon and if the observer were skillful and the sea not too rough could be held true. They were what we call stadimeters; a cross-piece was movable on a long piece whose inner end was held to the eye; the cross-piece is moved back and forth on the long piece until the 2 objects whose angular distance is to be ascertained—the horizon and a heavenly body for example—are on the 2 ends of the cross-piece. The distance of the cross-piece from the eye given by a scale on the long piece shows the angle.[6] The oldest account of this appliance was by Levi ben Gerson presented to Pope Clement VI in 1342.[7] Early European voyagers do not mention cross-staffs; neither Da Gama Columbus or Magellan use the word and Vespucius when made Chief Pilot with Extensive Power by the King of Spain in 1508 was directed to examine pilots in use of astrolabes and quadrants but nothing was said of fore-staffs.[8]

Perhaps in these respects the Arabs were doing better than western Europe. When Da Gama arrived in the East and obtained Arab pilots to

[4] Barros Asia dec 14, 2: a *palmo* is the distance between extremities of thumb and little finger when the hand is extended; tres palmos is about 20 inches. Champlain's astrolabe for use in a ship was 8 inches in diameter; see above p 62. The word rendered latitude is in Barros *altura*.

[5] See just below and p 60 above.

[6] Illustrations will be found p 201, Constr and Prin Uses of Math Instr trans from the French of Biot (died 1733) by Stone 2d ed; in Ravenstein's Behaim and His Globe pp 15–17 and in other places: see picture inserted p 60.

[7] Bensaude Astr Naut p 54.

[8] Above p 295; also remarks John Davis p 345 below.

guide him to India he was surprised by certain instruments they used. He showed the principal Arab pilot, Barros says his name was Malemo Cama, " The great astrolabe of wood which his ship carried and the others of metal with which he took the height of the sun: the Moor was not astonished saying the pilots of the Red Sea used brass instruments of triangular form and quadrants to take the height of the sun and stars. xx He said they used certain stars both of the north and south and the sun as well as certain stars which traversed the middle of the heavens from east to west, but they did not take their altitude with instruments similar to the Portuguese ones: he brought their instrument to show, which *was of 3 plates.* x x Since the shape and use of this instrument is shown in my Geography in the chapter on Instruments of Navigation it is enough to say here that our mariners now use it calling it *balhestilla.*" [9] This is the only technical intimation as to the instrument the Arabs were using adopted by the Portuguese and called balhestilla; Osorio an almost contemporary historian wrote,[1] " So great was the skill of the Arab pilots in all these arts they seemed very litle inferior to the Portuguese." Perhaps the instrument with 3 plates was the parallactic ruler used by Ptolemy 1500 years before which held on the zenith or horizon and was not subject to the error of astrolabes and quadrants which hung on the hand of the observer. Possibly seamen of Arabia in Alexandria in about the day of Ptolemy had seen this and adopted it.[2]

The fore- or cross-staff was much esteemed. John Davis correctly called The Navigator for his life is epochal in the history of navigation wrote in his Booke of Seaman's Secrets of 1580, " The instruments necessary for a skillful seaman are the sea-compass cross-staff quadrant astrolabe chart and an instrument magnetical for finding the variation of the compass: xx but the sea-compass chart and cross-staff are instruments sufficient for the seaman's use; the astrolabe and quadrant being instru-

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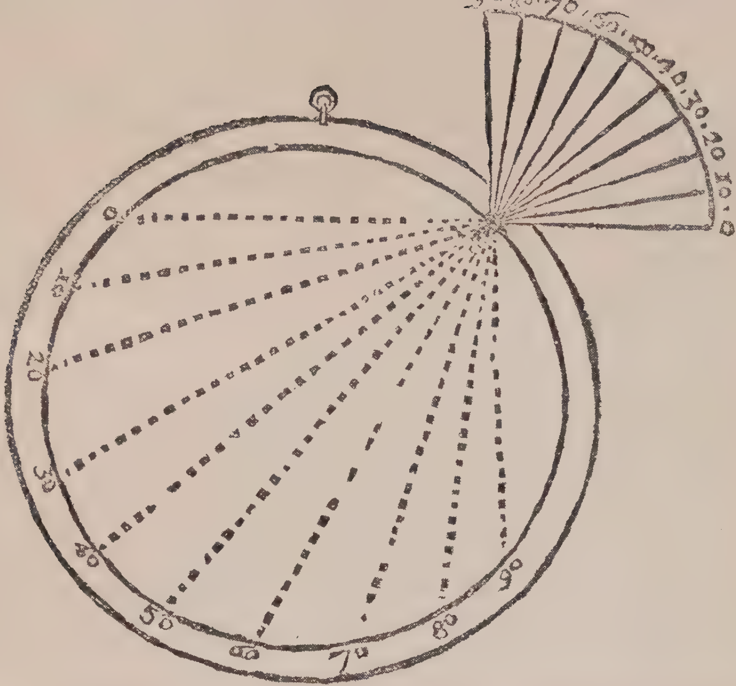
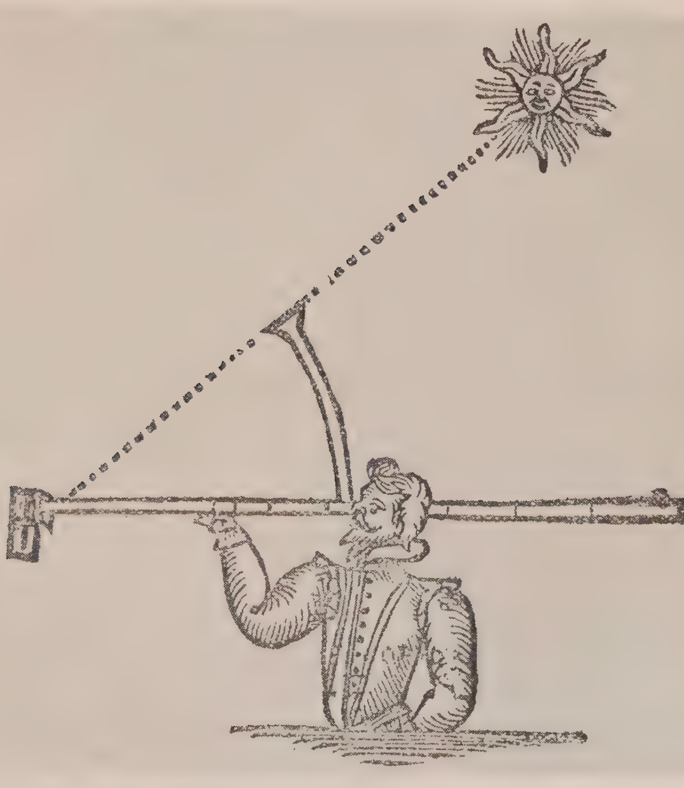
[9] Barros' Asia dec 1, 4, 6. An Eng trans will be found in note p 138 Three Voy Da Gama Hakl. The Geography of Barros was probably not finished; at all events it is not now extant. The form of the *tres taboas*, translated *three plates*, is not known. The word *balhestilia* now means in Portuguese and Spanish a cross- or fore-staff and it is generally supposed the pilot showed Da Gama what came to be called a balhestilla. The word is variously spelled and is so like the word, also variously spelled, for a *balista* or cross-bow as to give rise to confusion. See below p 347 n 9 for remarks of Correa a co-temporary as to skill of Arab pilots.

[1] Hist Reign Emmanuel v 1 p 51; he wrote in 1571.

[2] Above p 60 as to paral ruler of Ptolemy.





The upper figure shows Davis' idea of enlarging the degrees and lower one his back-staff in use; the first is at p 337 and second p 332 his work called The Seaman's Secrets, which book he dedicated 20th August 1594. See above p 60 for fore-staff in use.

ments very uncertain for sea observations." [3] Davis describes how to make and use a cross-staff mentions sailing on the shortest distance between 2 places and shows how to, "Enlarge the degrees contained in the astrolabe xx by conveying the degrees into the concavity xx whereby these degrees shall be doubled to any other astrolabe of the same quantity; so that the sunbeam piercing a hole made in the side of the astrolabe is thereby carried to the degree noted in the opposite concave part xx." [4]

THE BACK-STAFF.

With the back-staff invented by Davis we come close to modern instruments. He writes regarding it,[5] " The use of this staff is altogether contrary to the other for the center of this staff where the brass plate is fastened must be turned to that part of the horizon which is from the sun, and with your back to the sun by the lower edge of the half-cross and through the slit of the plate you must direct your sight only to the horizon, and then moving the transversary as occasion requireth until the shadow of the upper edge of the transversary do fall upon the said slit or long hole and also at the same instant you see the horizon through the slit and then the transversary showeth the height desired." This would give results nearly as accurate as those of modern instruments; unlike the fore-staff but like modern instruments the observer had to look only at the horizon, the sun or star was brought to his eye by reflecting it.

MEASURING SPEED.

The ordinary log consisting of a piece of wood or of a little board weighted to make it float upright and attached to the log-line by a crow's-foot—which 2 devices make the board keep at right-angles to the direction in which the log-line would draw it through the water—is alluded to

[3] Voy Davis 1550–1605 Hakl p 240: p 239 we read, "Navigation is that excellent art which demonstrateth by infallible conclusion how a ship may be conducted the shortest good way from place to place by Course and Traverse: xx Great Circle Navigation which teacheth how upon a Great Circle drawn between any 2 places assigned being the only shortest way between place and place the ship may be conducted xx."

[4] Work cited p 263, same p is this, "How I shall know the true order of placing the cross-staff to mine eye to avoid error in my observation;" p 336, remarks as to reflecting a beam of light in an instrument to double the length of the degree-marks.

[5] P 332; a cut is given and here reproduced; on p following Davis refers to, "Uncertainty of the sight by disorderly placing of the staff to the eye."

in Davis' Voyages published by the Hakluyt Society [a] and described for the first time by Wm Bourne in his Regiment of the Sea, the date of Davis and Bourne being about 1550.[6] There can be no doubt this log had been for some time in English ships at the date Bourne describes it and no doubt also that French and Spanish ships measured speed by what they called *estime* without this apparatus until later than 1667 when the Frenchman Fournier wrote his Hydrographie.[7] Bourne advises,[b] "The astrolabe is best to take the height of the sun when very high at 60, 70, or 80 degrees and then it is not good to use the cross-staff for that the sun hurteth the eyes of the man xx if you have not glasses on your staff to save your eyes."

A description of the little board of the log and arrangements by which it is kept upright in the water and as nearly stationary as possible is followed by directions how to proceed; [c] "To know the ship's way some do this; xx having line so ready that it goeth out as fast as the ship goeth and in like manner either an hour-glass of a minute or else a known part of an hour by some number of words or other such like, so that the line being veered out may be stopped just with that time that the glass is out or the number of words spoken. Which done they haul in the log or piece of wood again and look how many fathoms the ship hath gone in that time. That being known what part of a league soever it be they multiply the number of fathoms by the portion of time or part of an hour. xx As for example: I having a minute-glass; but it is better to have some portion of time by some number of words, and the lesser part of time that you have it is the better, for if the ship do go very fast you shall not have so much line out; and if the ship doth go but slowly then you double the length of time by speaking the words twice or thrice over xx. And so you may keep very good reckoning xx if you do this as often times as the wind doth increase or decrease; xx for an English league doth contain 2500 fathoms and a

[a] P 357.

[6] There is a copy of Bourne in Boston Pub and 2 in N Y Pub Library. The former is without printed date and on the title-page has been written 1577; but this cannot be the date of the first edition for it contains tables of sun's declination 1572–76: one copy in N Y has printed date 1596 and the other is undated and both in words at the beginning addressed Gentle Reader state the issue to be, "The third time of the impression of this book." The 3 copies contain the same pictures and seem identical. Editions were published until 1628.

[7] Above pp 48, 294. See below pp 557, 625, for pictures in Bourne of ship under sail and Balla Stella or Crosse Staffe and Astorolob or Ring. That the English were the first to use this appliance is proved by Champlain, who, writing about 1610 says he, "Has seen it used by good English navigators:" see p 50 v 6 Œuvres de Champlain Laverdiere.

[b] P 27 ed in Boston: this shows colored glasses were used.

[c] P 42 Boston ed and 48 N Y eds.

Spanish or Portuguese league doth contain 2857 fathoms." This makes the 2 leagues 2.5 and 2.8 geographical or sea miles.

Just following the above we read, "The 15th Chapter or Rule which Treateth of the Longitude: Now some there be very inquisitive to have a way to find the longitude, but that is too tedious. Now the latitude you can find with instruments, but the longitude you must bring forward from another place, which you can do with a globe or else a map or chart xx. And in our latitude of London every 555 miles, which containeth 15 degrees, will answer to one hour of time." This is just right; but it is no wonder it should be for by Bourne's day there were numerous treatises on navigation and many included a table giving the number of miles in a degree of longitude on each parallel of latitude: which, together with the fact that Bourne says ships must rely on dead-reckoning to determine longitude shows how well these things were understood.

OTHER APPLIANCES OF NAVIGATING.

Following Davis' back-staff have come modern instruments called sextants quadrants etc which are familiar and will not be described. Thus angle-measuring instruments are brought down to our day. It was estimated above that observations for latitude about 1500 were not likely to be wrong as much as 100 miles and was stated as to longitudes by observation at sea that there were none which could be used as a guide.[8] Perhaps observations were rarely taken in the Mediterranean pilotage being relied on but it is hard to believe ships in the Atlantic, and many were there earlier than 1400—Genoese Venetian Catalan Spanish French English Scandinavian and others,—were not so provided as to take care of themselves if blown away to sea. It is also hard to believe ships navigating the great eastern oceans did not use observations for latitude, though like the people of Europe they were without means of determining longitude. Da Gama found the Arab pilots the equals of his own:[9] we may say sea-faring grew nearly independently for thousands of years in the West and East and reached states not unlike, though indicated it was more advanced in the East than West.

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[8] Pp 339–40 above.

[9] See just above what Barros and Osorio both nearly contemporary say of Arab pilots; and Three Voy Da Gama Hakl p 261 for Correa also nearly contemporary in regard to those Gama picked up on the return voyage, "The Portuguese navigators thus with a good wind and at their ease relying on the good pilots they had, for they xx used to say tomorrow we shall see such a land or river or islands and they were always correct without making any mistakes xx."

THE APPROACH TO MODERN METHODS.

In about 1550 with Davis' back-staff and correct tables of declination latitude by observation was nearly as reliable as now as were also latitude and longitude by dead-reckoning, but longitude by observation was non-existent.[1] In the present day after using chronometers 150 years navigators have pretty much laid them aside, for in many parts of the earth they have only to set a watch to their own time by a sight in the forenoon and await this in hand the noon-signal from shore. When this is heard to determine the longitude a pencil is not needed. At noon the altitude of the sun is observed and latitude obtained also by mental arithmetic.

EARLY BROAD-CAST SIGNALS FOR LONGITUDE.

In about 1750 because of the need for longitude determination then on the threshold of satisfactory solution it was proposed to, "Anchor vessels at sea every 200 leagues, at midnight precisely these vessels will fire a bomb which should burst at a height of 6440 feet. xx It is only necessary to arrange the fuze."[2]

LISTS OF NAVIGATIONAL AND OTHER OUTFITS.

There are several lists of instruments charts etc. The one for Magellan's ship is dated 1522 and as follows:[3]

25 charts on parchment made by Nuno Garcia
6 pairs of compasses
21 quadrants of wood
6 astrolabes of metal
1 astrolabe of wood
35 steering-needles
4 large boxes for 4 needles
18 sand-glasses (Relojes de arena).

In the same volume there is,[4] "A Relation of the Costs of the Armada" in

[1] Pp 49–59 Voy Davis Hakl. He heads his log, A Traverse Book Made by Mr John Davis; it has the entries now usual. The ship went, "Northwestward xx for the discovery of a passage to the Isles of the Molucca or the coast of China in the year 1587:" Davis says of the voyage, "I have been in 73° finding the sea all open and 40 leagues between land and land. The passage is most probable the execution easy xx."

[2] Art de Mesurer le Sillage du Vaisseau Saverien 1750 p XVI. Practical men will see difficulties but it could probably be done if worth while.

[3] Navarrete v 4 p 8; see also pp 321 and foll'g above.

[4] Pp 162–182.

which we read, "Ship Victoria of the burden of 85 tons with her masts rigging and sails and boat" cost $1125.00;[5] that the cost of 58 *versos* 7 *falcones* 3 *lombardas* 3 *pasamuros*,[6] all made at Bilbao, was $600.51. In the lists only once is a gun-mount referred to and the cost is so small they must have been of very primitive form and construction.[7] Not until almost the present day was attention paid to mounts, although they put guns in the power of the gunner; the consequence was inaccurate and slow fire. For 50 *quintals*, 1000 lbs, of powder in barrels was paid $390.75; and there is separate entry for powder for proof of guns to be received from Bilbao. There is a list of, "Artillery Powder and Articles Necessary for These;" to wit, *ballestas* arrows *espingardas* [8] pikes and other arms; and one of, "Cartas de Marear Quadrants Astrolabes Sailing-Needles and Relojes Supplied the Armada, $255.68." [9]

Then the inventory goes on: "$4.22 to buy parchment to make charts; $3.37 for a dozen skins for this purpose and $3.28 for another dozen; $49.22 for 7 sailing-charts made by order of Rui Falero at 5 ducats.[1] $42.20 paid for 11 sailing-charts made by order of Fernando Magallanes; $50.99 for another 6 sailing-charts that Rui Falero had made with one sent to His Majesty." Then come more instruments; "$4.40 for 6 quadrants of wood made by Rui Falero; $2.81 for a wooden astrolabe made by the said Rui Falero; $16.88 paid to Captain Magallanes for a *plano esferico* he had made for His Majesty; $16.88 paid the said Magallanes for 6 astrolabes of metal with their pautas;[2] $15.30 paid

[5] This and all sums of money are given in Navarette in *maravedis* which were worth ½ to ¼ of our pennies; they have been converted into our money by multiplying by 3/8.

[6] These 4 are long small-bore guns of what we call high-power; there must be error for the average stated is less than $10.

[7] Below pp 351 n 8, 354.

[8] These are hand powder-guns; ballestas are cross-bows.

[9] Cartas de marear are sailing-charts; relojes are watches, sand-glasses: until almost our day the ordinary time of ships was kept by half-hour and hour sand-glasses.

[1] The ducat was about $2.30: the words must mean Rui Falero was paid 5 ducats for each chart; $11.50 for each. The statements in Navarrete cannot always be reconciled; one way of taking the last results in a price of $7.03 for each chart the other $10.50. The charts were made by hand painted in colors and on parchment; they probably cost little less than $10.00, a large sum in the day. Rui Falero was a cosmographer and friend of Magellan and was to have gone in his ship but did not; it is said Magellan took with him in manuscript 30 chapters of Falero's *Regimento para Observar la Longitude en la Mar* 1535, that is Rules for Finding Longitude at Sea; these were printed in 1535, see Bensaude Astron Nautique pp 163, 176.

[2] This means rule, guide: it means here either the bar carrying the sights pivoted at the astrolabe's center or the circular plates attached by which problems were solved without calculation.

to the former for 15 steering-needles; $7.03 paid the aforesaid for 15 quadrants of wood *abrozuados;* $1.78 for a pair of compasses (dividers) with their box which the aforesaid sent with the chart to His Majesty; $1.27 for a leather box made for the *Plano esferico;* $2.30 for 12 sand-glasses the captain bought; $2.81 for 2 steering-needles that the said captain had; $2.25 for 6 pairs of compasses; $2.81 for 2 steering-needles; $0.51 for repairing a steering-needle which was damaged; $3.31 for 4 large boxes for 4 steering-needles made for Rui Falero; $22.85 for 16 steering-needles and 6 sand-glasses (relojes): all the above amounts as more particularly set forth in the book of the said armada come to $255.68."

No book treating of navigation or giving tables showing positions of celestial bodies is included but both Magellan and Columbus had these. The history of Magellan's voyage shows his pilots tried to determine longitude by observation and were unsuccessful because the tables were in error. The reason these do not appear in the lists is because navigational appliances were made and furnished by pilots not drawn from government stores. The lists quoted are no doubt government's, were made for some reason not apparent after the Victoria returned, and in them all of navigational character is bought from a pilot or cosmographer.

STRIPS OF LEAD ON SHIPS' BOTTOMS TO HOLD THE CAULKING IN PLACE.

Magellan's ships carried both stone and metal projectiles for guns and molds to make those of metal. They had 5532 pounds of lead; of which 2100 pounds was to be, "*Gasto y labro en planchas para emplomar las costuras de las naos,*" [3] that is, " Used at once and worked into plates to lead the seams of the ships." This statement is of date before 1519 when Magellan sailed, before experience had been gained of the insects in equatorial latitudes which bore through ships' bottoms. To prevent this the entire bottom must be covered while the purpose of the lead strips was to keep the caulking from falling out when the ship worked. Covering the entire bottom with metal plates is mentioned by Sarmiento de Gamboa 75 years after Magellan's day, after it was found ships could be destroyed by insects. Covering seams to retain caulking was used by Egyptian ships about 250 B C and is possibly what was on the recovered ship of Trajan's day 100 A D.[4] It is probable the custom lasted until replaced by covering

[3] Navar v 4 p 618.

[4] Above pp 79, 225; below p 630 for Sarmiento's mention.

the bottom entire. I am not aware of a mention of either class of metal coverings on ships of the Far East though they were often in equatorial latitudes and in the heavy seas found in large oceans; but they were covered with water-proof glue in which was mixed shells strands of string etc to make it difficult to perforate.

OTHER LISTS OF SUPPLIES.

The views of John Davis as to appliances ships should carry have been given.[5] The Inventions and Accounts of Henry VII of England 1485–1509 [6] list the following appliances in ships, "Running-glasses lead-lines sounding-leads steering-compasses;" but no log or log-line: the running-glasses show however that speed was measured: they were probably sand-glasses and with them and a plan for measuring the distance the ship sailed while they ran out, possibly not a log-line, a measured rope, but something cruder, speed was measured.[7] Frobisher gives a list of appliances he took in 1576–8 in search of north-west passage to China and India; [8] "A great globe of metal in blank in a case; an instrument of brass named a *compassum meridianum;* an instrument of wood; a staff named *balestella;* a very great carte of navigation; a great map universal in printe [9] of Mercator; 20 compasses of divers sorts; 18 hour-glasses; an astrolabium xx." The ship carried then a great metal globe probably with celestial bodies marked to be used in observing; a *compassum meridianum,* possibly to attach to the globe when observing meridian altitude; a cross- or fore-staff, not Davis' back-staff; (Frobisher calls this *balestella,* the name of the instrument found by the Portuguese in the hands of Arabs 100 years earlier); [1] a *very great* carte of navigation; a *great* map of Mercator; 20 steering-compasses; an assortment of 18 hour-glasses; an astrolabe.

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[5] P 344.

[6] Eng Navy Records Soc Pub.

[7] Above p 345.

[8] Voy Frobisher Hakl p IX. There are other interesting passages in this: p XI list of costs of instruments; p 29, long remarks about compasses; p 221, cost of mounts for 5 guns was £6, 18s, about $5 each; no wonder gun-fire was slow and inaccurate: see above pp 348–49.

[9] It is unlikely this means copies were produced by printing and unlikely the map was on Mercator projection: see pp 87–8 Intro Voy Davis Hakl for history of Mercator charts; the date of the oldest is 1569 and 30 years later they were commonly in ships.

[1] Above p 343. It will be seen that with the metal globe and compassum meridianum latitude could be determined, no table of declination being necessary nor arithmetical work.

THE CARTE PISANE (1300) AND FROBISHER'S VERY GREAT CARTE (1576) CONTRASTED.

The log is so simple no one mentions it but Frobisher must have used one for the numerous and various sand-glasses point to this. The most interesting thing he carried is the *very great carte of navigation*, which may still be seen in England at Hatfield.[2] It covers the Atlantic Ocean from the coast of Great Britain west to the south point of Greenland and beyond far enough to show the American continent in and about Frobisher Bay. From the coast of Scotland to the last is 2200 miles and as the map is drawn on a parchment 33½ by 27 inches its scale is 60 miles to an inch; just that of the Carte Pisane drawn by and for seamen 300 years earlier.

The likeness between the Carte Pisane and Frobisher's does not end here. The Carte Pisane shows the Mediterranean and Black Seas and Frobisher's [3] the Atlantic Ocean on the far side of which Frobisher hoped to find a strait to serve as a short way to the East. The makers of these maps, separated by 3 centuries or more, selected points about the middle of the regions they intended to show; the earlier group taking one in the middle of the Mediterranean and another in the middle of the Black Sea in both which the ships of Pisa traded; the later took one in the Atlantic half-way between Scotland and the mouth of Frobisher Bay. Circles drawn on the 2 charts swept around the seas and harbors it was wished to show. On the circles 16 points equally spaced were taken and through these radiating lines drawn. So far the parchments before the 2 sets of map-makers were blank except for the lines described: after these were drawn coast-lines islands etc were put in using the radiating lines to give direction and a scale on the charts for distances.

The 2 charts have 2 points of difference of such character as to fix the conclusion that charts were long made and used—for using and making are reversed processes—in the way described: (1) the large circle is itself drawn in on the Carte Pisane while on Frobisher's chart it is not drawn though the 16 equally spaced points show where it comes, (2) on the Carte Pisane 9 radiating lines are drawn *inwards* from the large

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[2] P 30 Christy The Silver Map; the map's history is given. See pp 327 and foll'g above as to use of charts such as here under review.

[3] It is signed, "The first of June 1576. By Wm Borough." Borough was a famous person in his day. The Catalan Map 1375 is made on the same plan as those under review: see p 302 above.

circles and 16 radiating lines pass through the center; on Frobisher's chart there are 32 radiating lines through each of the 16 points on the large circle and these lines do not stop at this circle but go across it, thus covering the area outside the circle; also the Frobisher chart has 32 radiating lines at equal angles through its center, double what the Carte Pisane shows. These are not differences and the charts were made and used in the same manner and as described. Before anything else was done 32 lines were drawn through each of the 16 points on the large circle of the Frobisher chart and 9 through each on the Carte Pisane; 512 lines on the former and 144 on the latter: these gave everywhere necessary directions. Why seamen preferred this to the ways now employed it is hard to say, and it should be noted that globes and some maps of the day manifestly not for use in ships show only the lines we use. The change to the method now used was not far off in Frobisher's day. The Catalan Chart 1375 was made and used in the same manner with the numerous radiating lines.[4] In the *Arte de la Verdadera Navegacion* of Pedro de Syria printed at Valencia in 1602 will be found explanations, "How to Make a Sailing Needle, How to Make a Carta de Marear, How to Use a Carta de Marear, How to Know the Leagues the Ship Has Gone on Any Wind or Rumbo,"[a] which will help to make clear the methods of the day.

MERCATOR CHARTS: PARALLEL RULERS.

Frobisher says he had a Mercator chart. On these the track of a ship on one course is straight and with a Rose of the Winds or Dumb-Compass on the chart and parallel-rulers courses are easily transferred anywhere. A dumb-compass is drawn on the Catalan Chart 1375 and the invention of parallel-rulers is ascribed to Mordente about 1580. With these and a pair of dividers to measure with, appliances of great antiquity, the great carte of Mercator and a board to lay the last on, Frobisher's pilot worked as navigators work now, except that most of his work was done graphically not by calculating.

THE HAWKINS VOYAGES.

The Hawkins voyages followed those of Frobisher shortly, their date being 1593,[5] but in these there is no list of instruments. The

[4] Above pp 302 and foll'g.

[a] At pp 55, 66, 72, 97. This work will be found in Boston Pub Library and perhaps elsewhere. There is also in the same library the *Compendio del Arte de Navegar* Camorano printed Seville 1591.

[5] Hawkins Voy and Obs Sir R Hawkins, Hakl.

Hawkins captains knew how to fight the scurvy, a terrible scourge in the long voyages common in the day, knew about the trades and other wind currents, and Richard Hawkins writes of what we call interior ballisties, the science of movement of projectiles while gaining velocity in a gun. He says [6] because longitude cannot be found at sea it is best to search for land by sailing east or west; and commends Spanish and Portuguese practice thus; [7] "In every ship of moment they have on the half or quarter deck a chair or seat out of which xx the pilot or his adjutants never depart day or night from the sight of the compass and have another before them whereby they see what they do xx." This seems to mean the helmsman had no compass before him and for many years pilots had a compass before them and the helmsman none and moved the helm as directed.

THE POOR QUALITY OF GUN MOUNTS.

The statement of Frobisher quoted, that 5 gun-mounts cost £6 18s, must not be passed by. This is about $6 for a mount and implies what is known otherwise they were made of pieces of wood pinned together and often without trucks under them. Even so we cannot justify the cost except by supposing them made by ship-carpenters of left-over pieces and items of cost which would now be included omitted. Though there is no statement to that effect the mounts for standing throwing-machines were probably made only when wanted. Mounts of ship and shore artillery were long neglected; at present due principally to this having been remedied gun-fire is more accurate than formerly, and though the guns are heavier they are fired faster. This result making each pound in a gun more efficient is due to better mounts; yet comparison between guns of former days and now is not complete until the length of time each can be fired continuously is set down and this for modern large guns is less than usually admitted. As an off-set it is said modern battles will be short but Ruiter's fleet fought once for 4 days and modern battles may last longer than supposed.

THE BARENTZ RELICS.

Barentz searching a N W passage to India in 1594 was lost in the far north and 275 years later the camp where the last of his men died was found: [8] in it were the remains of a clock driven by a weight and without

[6] P 135 his book cited.

[7] P 165.

[8] Voy Barentz Beynen and Beke Hakl: Barentz Relics De Jonge.

pendulum, " A circular-shaped flexible bar of iron probably a spring," part of a compass with a circular card fixed on the needle; all now in the Naval Museum at the Hague. In the second work mentioned in the note above are many illustrations and among these some show firearms handled each by one man only which was not always the case in these days. They have firing-locks, with flints no doubt; but perhaps the illustrations are modern and in error.

TELESCOPES.

Jal gives a list [9] from Strutt's Chronicle of articles onboard the English ship Vyenroyd including, " Three compassys; a Kennying-glass; a great boat pertaining to the ship with a davyd with a shyver of brass." The date is 1532. Captain John Saris who in 1613 took to Japan the first English ship that went there gave the Emperor, " One prospective glass cast in silver-gilt." [1]

NAVIGATION APPLIANCES AGAIN.

In the voyage of Captains Fox and James in search of a N W passage to the East in 1631–2 we see determination to find and use the shortest route to the East whatever hardship it might entail, for English ships had gone east around the Cape of Good Hope 40 years before this. The points of interest in the narrative are; [2] Fox had and used an astrolabe; speaks of a *log-board*, presumably to write the first record on; James', " Clock and watch xx were so frozen they would not go;" the captains measure the sun's refraction at rising and setting; James observes twice for longitude, one of his results being almost exactly correct. Then comes, " Names of the Several Instruments I Provided and Brought for This Voyage "—apparently all were, " Old seasoned peartree wood,"—as follows, " A quadrant divided to minutes of arc of 4-foot semi-diameter; a staff of 7 feet long whose transome was 4 feet; 3 jacob's-staves; 2 of Master Davis' Back-Staves; 4 special needles of 6 inches diameter and toucht curiously with the best lode-stone in England; a lodestone to refresh any of these if occasion were whose poles were marked for fear of mistaking; a watch-clock of 6 inches diameter and another lesser watch; a chest full of the best and choicest books that could be got for money in England; a log-line."

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[9] Arch Nav v 2 pp 280, 284.

[1] Voy Saris Hakl p 113: see below as to spy-glasses again.

[2] Hakl v 1 pp 250, 371, 535, 558, 604.

The last was marked for use. This book includes An Appendix Touching Longitude written by Henry Gellibrand born 1597. He writes, "As for the magnetical needle to argue a longitude from its variation is altogether without ground. And though well-furnished seamen are able by their dead-reckonings as they term them to determine the difference of meridians somewhat near yet xx." Then he describes an observation of the moon's eclipse made in London with, "A quadrant of six foot radius actually cut to each minute of the quadrant." He had a clock but does not say how it was regulated; the description is full enough to be interesting but not to determine how correct the result was. The quadrant of 12 feet diameter was of course supported by frame-work; it would give accurate determinations.